Printed on Thin Paper for Foreign Circulation.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C.2.

VOL. CXXXVIII.—No. 3597] LONDON: FRIDAY EVENING, DECEMBER 5, 1924 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

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A New System of Railway Electrification.

Lost Torque in Marine Engines.

Solid Crank Axles.

Wire-Drawing and Wire-Working Machinery (No. XVIII.).

Costing and Time Booking.

Hydraulic Transmission Gears for Motorships.

The Magnus Effect.

100 Years of British Railways—No. XXIII.

A New Water Level Indicator.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere road, Lambeth, S.E. 1, REQUIRES :—

1. BUFFERS and PLUNGERS and SOCKETS for BUFFERS for RAILWAY WAGONS.
2. COPPER BOLT, HARD ROLLED STAY BARS.

Tenders due on the 14th December, 1924, for No. 1, and on the 19th December, 1924, for No. 2.
Tender forms obtainable from above. 7713

Assistant Engineer Re- QUIRED by the GOVERNMENT of the GOLD COAST for service with the Kumasi Public Health Board for a tour of 12 to 18 months' service, with possible extension. Salary £480 for the first three years of service, then £510, rising to £720 a year by annual increments of £30, and thence to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters and passage. Liberal leave on full salary. Candidates, age 25 to 35, preferably single, must be A.M.I.C.E. or A.M.I. Mun. and Cr. E., or hold equivalent professional qualifications. Must have had a good office training, preferably in a municipal engineer's office, be good surveyors and have had experience in drainage, town planning and other municipal works.—Apply at once, stating age, qualifications, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/13,286. 7676

Civil Engineers Required by the GOVERNMENT of the GOLD COAST, for the PUBLIC WORKS DEPARTMENT, for two tours of 12 to 18 months' service, with possible extension. Salary £480 for the first three years of service, then £510, rising to £720 a year by annual increments of £30, and then rising to £920 by annual increments of £40. Outfit allowance £60 on first appointment. Free quarters and passages and liberal leave at home on full salary. Candidates, age between 25 and 35, must be fully qualified Civil Engineers, and have had practical and general experience on the Construction of Roads, Buildings and other Public Works.—Apply at once, in writing, stating age and giving brief details of experience and qualifications, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting clearly at head of application M/13,115. 7714

Ministry of Transport. ROADS DEPARTMENT. TEMPORARY ENGINEERS.

APPLICATIONS are INVITED for a limited number of TEMPORARY APPOINTMENTS as ENGINEERS, at salaries of £300 to £500 per annum inclusive, according to the post and to experience and qualifications.

These appointments are in connection with Road schemes throughout England and Wales, but there are at present vacancies in London only.

Practical and experienced men with a knowledge of local administration and of Modern Road and Bridge Construction are required, and preference will be given to men who have served in His Majesty's Forces.

Applications should be made immediately, in writing, to THE ESTABLISHMENT OFFICER, Ministry of Transport, 6, Whitehall-gardens, S.W. 1, stating age, qualifications, experience and references. 7699

Temporary Civil Engi- NEERING and ARCHITECTURAL ASSISTANTS (ex-Service men) RE-QUIRED for Government Department :—

(a) ENGINEERING POSTS.—Candidates must have had good training and experience in Civil Engineering, and be capable of Preparing Designs and Working Drawings and Making Calculations required in connection with Steel Structures of large dimensions and Ferro-concrete Work, or, alternatively, have had experience in Municipal or County Engineers' Offices, and be fully competent to Prepare Designs, Working Drawings and Specifications—under supervision—for Drainage and Sewage Disposal Works, Water Supply Schemes, Roads and General Civil Engineering Work.

(b) ARCHITECTURAL POSTS.—Candidates should have served articles and have had two or three years' additional training in Architects' Offices and be capable of Preparing Working Drawings and Specifications for Architectural Work.

Normal inclusive maximum salary £370 per annum, but salaries will be assessed according to qualifications and experience.

Written applications, with full details of experience, qualifications, age and salary required, should be addressed to the JOINT SUBSTITUTION BOARD (Treasury and Ministry of Labour), Montagu House, Whitehall, S.W. 1. 7696

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Wednesday, 17th December, TENDERS for the SUPPLY of—

(1) METALS.
(2) WOOD SCREWS, NAILS, SPLIT PINS, &c.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 2s. each for No. 1 and 10s. each for No. 2 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary.

Offices : 91, Petty France, Westminster, S.W. 1.
3rd December, 1924. 7705

County Borough of Wigan. SEWAGE DISPOSAL COMMITTEE. CONTRACT No. 8.

The Corporation invite TENDERS for the PROVISION and INSTALLATION of THREE SETS of ELECTRICALLY DRIVEN PUMPS at the Pemberton Sewage Works.

Plans, specification, conditions and form of Tender may be obtained on application to Mr. E. B. Donald, M. Inst. C.E., Borough Engineer, Municipal Buildings, Library-street, Wigan, on or after Friday, the 28th instant, on receipt of a deposit of £3 3s., made payable to the Corporation, which deposit will be returned to each person or firm submitting a bona fide Tender and returning the plan, specification and conditions.

Sealed Tenders, on the prescribed form of Tender, to be sent to me in the endorsed envelope supplied for the purpose, not later than 10 a.m. on the 16th December, 1924.

The Corporation do not bind themselves to accept the lowest or any Tender, and persons tendering do so at their own cost.

WILLIAM HENRY TYRER, Town Clerk.

Town Clerk's Office, Municipal Buildings, Library-street, Wigan.
24th November, 1924. 7615

PUBLIC NOTICES

County Borough of Eastbourne. BOROUGH ENGINEER AND SURVEYOR'S DEPARTMENT.

TENDERS are INVITED for the REMOVAL of existing TIDAL FLAPS, &c., in the Valve Chamber, Langney Point, and the SUPPLY and FIXING of NEW TIDAL and SLUICE VALVES.

Plans, specification, and form of Tender may be obtained from, and general conditions of contract seen at, the Borough Engineer's Office, Town Hall, Eastbourne, on and after the 8th December, on payment of a deposit of One Guinea, which will be refunded on receipt of a bona fide Tender and the return of the plans.

Sealed Tenders, endorsed "Valves, Langney Point," to be delivered at the Borough Engineer's office not later than 5th January, 1925.

The Corporation do not bind themselves to accept the lowest or any Tender.

LESLIE ROSEVEARE, M. Inst. C.E., Borough Engineer.

The Town Hall, Eastbourne, December, 1924. 7703

Napsbury Mental Hospital, NAPSBURY, ST. ALBANS. FOR DISPOSAL.

The Committee of this Hospital have a Manlove-Alliott DISINFECTOR, TWO PRESSURE WASHING MACHINES, TWO POWER BOX MANGLES, a Davey-Paxman VERTICAL STEAM ENGINE, and a QUANTITY of PIPE and STEAM TUBE FITTINGS FOR DISPOSAL. The surplus articles may be seen at any time except Saturdays and Sundays between the hours of 10 and 4.

Detailed lists may be obtained on application to the CLERK and STEWARD, and Offers should be sent not later than 31st December, 1924. 7689

Taf Fechan Water Supply BOARD.

TENDERS FOR STEEL PIPES, VALVES, &c.

The Taf Fechan Water Supply Board are prepared to receive TENDERS for the SUPPLY and DELIVERY at certain railway stations in South Wales of about 5000 TONS of STEEL SOCKET and SPIGOT PIPES of diameters ranging from 37in. to 17in., together with certain CAST IRON PIPES, VALVES and SPECIALS, all of British material and manufactures. Though lap-welded steel pipes are specified, tenderers are at liberty to offer other makes of steel pipes, but riveted pipes will not be accepted. Drawings may be seen and specification and form of Tender obtained at the offices of Sir Alex. Binnie Son and Deacon, 20, Buckingham-gate, Westminster, S.W. 1, on payment of a cheque for £5 made out to the Taf Fechan Water Supply Board, which amount will be returned on receipt of a bona fide Tender. Sealed Tenders, endorsed "Tender for Steel Pipes, Valves, &c.," should be delivered at my office at or before Noon on Tuesday, the 23rd day of December, 1924. The lowest or any Tender will not necessarily be accepted, nor will any expenses in connection with tendering be defrayed. No Tenders will be considered except from actual manufacturers capable of supplying the pipes at the rate of 600 tons per month, together with a proportionate number of valves and specials.

J. COLENSO JONES, Clerk to the Board.

Board's Offices : 101, High-street, Merthyr Tydfil. 1st December, 1924. 7660

Slough Urban District Council. WATERWORKS.

TENDERS are INVITED for the SINKING, LINING, and TESTING of a 30in. diameter BOREHOLE at Datchet, Bucks. Particulars can be obtained from the undersigned (on payment of £1 1s. deposit), and Tenders, endorsed "Bore-hole," must be delivered on or before Noon on Monday, the 15th December, 1924.

ALAN BROMLY, Water Engineer.

Slough, 1st December, 1924. 7669

PUBLIC NOTICES

BY ORDER OF THE RECEIVER. Re BRADBURY and CO., Ltd., WELLINGTON WORKS, WELLINGTON-STREET, OLDHAM.

For Sale by Private Treaty, the above valuable WORKS, together with the Boiler, Millwrights' Work, Steam, Water and Gas Piping and Sprinkler Installation.

The works, which are centrally situated, are situate up to three prominent streets and within 3 minutes' reach of TWO IMPORTANT RAILWAY STATIONS.

The buildings are substantial in character and can be adapted for many classes of business.

The main entrance is at present in Wellington-street, but a separate entrance to the premises could be made from the Brunswick-street side, which is an important thoroughfare.

NOTE.—It is possible for any purchaser of the works, if so desired, to divide up the premises for letting purposes.

The site contains 5597 square yards or thereabouts, and is subject to a yearly chief rent of £51 12s. 6d.

For further particulars and permission to view apply to ALLEN MELLOR and CO., Auctioneers and Valuers, 21, Queen-street, Oldham (Tel. Nos., 1698 and 1699). 7683

The Great Indian Peninsula RAILWAY COMPANY, 48, Cepthall-avenue, London, E.C. 2, invite TENDERS for :—

1. MISCELLANEOUS ARTICLES AND MATERIALS..... Fee 5s.

Tenders are due by 11 a.m. on 16th December, 1924. Tender forms obtainable at above address. Fees not returnable. 7701

The Madras and Southern MAHRATTA RAILWAY COMPANY, LTD.

The Directors are prepared to receive TENDERS for :—

400 LAMINATED BEARING SPRINGS (15 plates, 4in. by 1in.),

in accordance with the specification, which may be seen at the Company's offices. The charge for the specification is One Guinea, which will not be returned.

Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 23rd December, 1924, and marked "Tender for Laminated Springs."

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices : 25, Buckingham Palace-road, Westminster, S.W. 1.
2nd December, 1924. 7702

Torquay Town Council. WATERWORKS DEPARTMENT.

The Council of the Borough of Torquay is prepared to receive TENDERS for the COMPLETION of a SERVICE RESERVOIR and ANCILLARY WORKS at Great Hill, Torquay.

The Reservoir is to be constructed of Mass Concrete with Brick Lining and will have a Reinforced Concrete Roof supported on Brick Piers. The capacity of the Reservoir will be approximately 1,500,000 gallons.

Specifications and schedules may be obtained on application to the undersigned on payment of a deposit of Two Guineas, which will be returned on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Tender for Service Reservoir, Contract 12," together with specification and schedule of prices, must be delivered to the Town Clerk at his office, Town Hall, Torquay, before Noon, Monday, 15th December, 1924.

The Council does not bind itself to accept the lowest or any offer.

SAMUEL C. CHAPMAN, M. Inst. C.E., Waterworks Engineer.

Town Hall, Torquay, 29th November, 1924. 7668

PUBLIC NOTICES

The Committee of Management of the BENEVOLENT FUND of the INSTITUTION OF CIVIL ENGINEERS hereby convene an EXTRAORDINARY GENERAL MEETING of the CONTRIBUTORS to the FUND, to be held at the INSTITUTION, GREAT GEORGE-STREET, WESTMINSTER, S.W. 1, at Three p.m., on MONDAY, the 15th DECEMBER, for the purpose of appointing a Trustee of the Capital, in the place of the late Sir Maurice Fitzmaurice, C.M.G. 7679

The Broadstairs and St. Peter's URBAN DISTRICT COUNCIL, WATERWORKS DEPARTMENT, have FOR DISPOSAL the undermentioned STEAM PUMPING PLANT, which is being removed from their Rumdelds Pumping Station, viz.:—

A Compound Condensing Deep-well Pumping Engine; Two Triple-expansion Worthington Pumping Engines; a Loco. Type Semi-portable Boiler, by Ruston and Proctor; a Lancashire Boiler, by Davey, Paxman and Co.; Deep-well Pumps and Rising Main and other Incidental Plant and Fittings.

Offers are invited for the whole or any complete part of the plant.—Apply, Mr. H. HURD, Waterworks Engineer, Pierremont Hall, Broadstairs. 7699

Epsom Urban District Council. APPOINTMENT OF ASSISTANT ELECTRICAL ENGINEER.

The Council invites APPLICATIONS for the above APPOINTMENT from fully qualified Electrical Engineers, who must have had experience in Electricity Works, with Diesel and Steam Engines and Three-wire System of Distribution.

The salary will be £350 per annum, which will carry no bonus, but will be subject to percentage deduction in accordance with the Local Government and other Officers' Superannuation Act, 1922, which has been adopted by the Council.

The person appointed must devote his whole time to the office.

Applications, stating age (which must not exceed 40), qualifications, experience, and the earliest date upon which the applicant can commence duties, accompanied by copies only of not more than three recent testimonials, must be sent to me in envelopes, endorsed "Assistant Electrical Engineer," so that they shall be received at 37, Church-street, Epsom not later than 6 p.m. on Tuesday, the 16th December, 1924.

Canvassing, either directly or indirectly, will be considered a disqualification.

E. G. WILSON, Clerk of the Council. 7650

Metropolitan Water Board. MECHANICAL ENGINEERING ASSISTANT.

The Metropolitan Water Board invite APPLICATIONS for the APPOINTMENT of a MECHANICAL ENGINEERING ASSISTANT at a commencing salary of £280 per annum plus bonus. Applicants, who should be between 26 and 40 years of age, must be engineers having an extensive practical knowledge of the manufacture and operation of steam engines and boilers, and should possess a first-class Marine Engineer's Certificate from the Board of Trade. The appointment will be held during the pleasure of the Board.

The salary above mentioned is based on pre-war conditions and is subject to a temporary fluctuating bonus which at the present time amounts to £118 7s. 11d. Subject to a satisfactory report by the Chief Engineer, the basic salary will be increased to £300 as from the 1st April, 1926.

Applications (which must be in the candidate's own handwriting), stating age, qualifications and experience, and accompanied by copies of not more than three testimonials, must be addressed to the undersigned, endorsed "Mechanical Engineering Assistant," and must reach the offices of the Board not later than Twelve o'clock Noon on Thursday, the 18th December, 1924.

The selected candidate will be required to pass satisfactorily a medical examination by the Board's Chief Medical Officer and to undertake in writing to join the Board's Superannuation and Provident Fund.

Canvassing is strictly prohibited and will disqualify.

G. F. STRINGER, Clerk of the Board.

New River Head, 173, Rosebery-avenue, Clerkenwell, E.C. 1, December, 1924. 7660

South Staffordshire Water- WORKS COMPANY. MECHANICAL DEPARTMENT.

APPLICATIONS are INVITED for an experienced MECHANICAL ENGINEERING ASSISTANT. Must be a good Draughtsman and fully conversant with the Design and Construction of large Pumping Units of all types. Applicants having a knowledge of Electricity preferred.

Commencing salary, £275 per annum, which is subject to deductions under the Company's superannuation scheme.

Applications, with copies of three recent testimonials, should state experience, age and when at liberty, and be addressed to the undersigned, endorsed "Mechanical Assistant."

FRED. J. DIXON, M. Inst. C.E., Engineer-in-Chief.

Engineer's Office, 28a, Paradise-street, Birmingham. 3rd December, 1924. 7715

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PUBLIC NOTICES

DIRECTOR OF RESEARCH FOR CHILEAN NITRATE INDUSTRY.

The Association of Producers of NITRATE of SODA in Chile intends to organise a Central Research Department in that country.

A DIRECTOR of RESEARCH, salary £3000 per annum, and TWO SUB-DIRECTORS, salaries £2500 each per annum, are REQUIRED. The appointments will be for three years in the first instance. Chemists, or Chemical Engineers, with first-class scientific training and successful experience in the scientific investigation, design, and operation of large-scale processes and plant, are wanted for these posts. Applicants should be, if possible, between 35 and 45 years of age. No previous knowledge of Spanish is required.

For further particulars apply to

THE SECRETARY,
THE CHILEAN NITRATE COMMITTEE,
Friars House,
New Broad-street, London, E.C. 2. 7712

The Municipality of Singapore, STRAITS SETTLEMENTS.

CHIEF ASSISTANT GAS ENGINEER. ADVERTISEMENT.

The Municipal Commissioners of Singapore REQUIRE a CHIEF ASSISTANT GAS ENGINEER, age about 30-35, of sound constitution, and unmarried. He must have had a good technical education, a regular training as a Gas Engineer, with general all-round experience, including Carbonising and Water-gas Plant, both in the design and in the construction of new works and in ordinary maintenance and in distribution.

The appointment will be on agreement for three years with possible extension. The selected candidate must pass a medical examination as to his fitness for service in a tropical climate. A passage will be provided with half salary during the voyage out.

The salary will be 7440 dollars for the first, 7920 dollars for the second, and 8400 dollars for the third year, paid monthly, the value of the dollar being two shillings and fourpence sterling. For the first year the salary would be equal to £868 as above, with an allowance for such transport as may be required when on duty.

Applications, stating age and place of birth, and giving details of education, training, and experience generally, and in carbonising machinery and water-gas plant, and stating when free, accompanied by copies (only) of testimonials, and also naming references, to be lodged with Messrs. C. C. LINDSAY and PEIRCE, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents to the Municipal Commissioners (from whom further information may be obtained), not later than Tuesday, 16th December, 1924. 7706

SITUATIONS OPEN

WANTED, ENGINEER for Bridge Building and Constructional Engineering Works in India, under British management; thorough knowledge required of modern works practice, designing, estimating, and erection. Age 32 to 40. Applicants should state previous experience and salary required.—Address, "Z. G. 180," c/o Deacon's, Leadenhall-street, London, E.C. 3. 7697 A

WANTED for Modern Steel Foundry, METALLURGIST for Steel Production and Heat Treatment. Experience in Siemens, Bessemer and Electric Furnaces desirable.

Apply in first instance to "FOUNDRY," c/o T. G. Shuttleworth and Son, Church-street, Sheffield, stating experience and remuneration required. 7674 A

ASSISTANT MANAGER REQUIRED for London by Firm of Merchants and Agents; must have engineering knowledge and be capable of negotiating orders and contracts. Age about 30, good presence and education essential. State age, references, and salary required.—Address, 7700, The Engineer Office. 7709 A

BOILER INSPECTOR.—Experienced INSPECTOR WANTED for Water-tube Boilers. State fully qualifications, experience, and salary required.—Address, 7677, The Engineer Office. 7677 A

ENGINEER.—REPRESENTATIVE WANTED, London, Cranes, Aerial Ropeways, Handling Plant. Chief qualification: the getting of orders. Applications treated in confidence.—Address, stating experience, salary expected, and when free, 7695, The Engineer Office. 7695 A

LIFT ESTIMATOR REQUIRED AT ONCE in office of well-known Lift Company. Must have good knowledge of Electrical Lift Engineering. State age, experience, and salary required.—Address, P9865, The Engineer Office. P9865 A

REQUIRED, Fully Qualified ENGINEER-SALESMAN, age 30-35. Thorough practical and chemical experience of petroleum technology. Fluent French and German an advantage. Replies, which will be treated in confidence, must give age, details of experience, salary expected, &c.—Address, 7644, The Engineer Office. 7644 A

RESIDENT ENGINEER REQUIRED for Canal Works, Southern Europe; preference given to one with Contractors' Experience.—Address, stating qualifications, P9885, The Engineer Office. P9885 A

TRACK ENGINEER WANTED for Large Tramway System, South Africa. Must be thoroughly experienced, able to survey, set out, and generally to take full charge on all systems of track work, the laying of rails and special work, welding by electricity and Thermit. Also be conversant with construction of roadways, granite and wood block, tar-macadam, Pisecom, &c.—Address, stating age, full particulars experience and salary required, 7685, The Engineer Office. 7685 A

WATERWORKS ENGINEER.—WANTED, for large Waterworks in Scotland, with large scheme in hand, a TEMPORARY ASSISTANT, with good experience of Pipe-laying and Concrete Work and Contractor's Final Measurements. Salary £330. Send chronological statement of experience, state of health, age and testimonials.—Address, 7640, The Engineer Office. 7640 A

WANTED, Good DRAUGHTSMEN for Electric Railway in London, used to Steel Rolling Stock. Please state present salary.—Address, P9864 The Engineer Office. P9864 A

ASSISTANT ENGINEER-DRAUGHTSMAN REQUIRED for firm of designing Engineers in North of England; both theoretical, shop and drawing-office training essential; experience in Gas Producer and Gasworks Plant an advantage.—Write, stating age, wage, experience, to "Z.R.197," c/o Deacon's Advt. Agency, Leadenhall-street, London, E.C. 7716 A

DRAUGHTSMAN, Experienced in Steam Engines and General Engineering, expert knowledge of Fans and Centrifugal Pumps desirable, sound estimating ability essential.—Address, stating age, experience, and salary, 7605, The Engineer Office. 7605 A

DRAUGHTSMEN.—ONE or TWO First-class BOILER DRAUGHTSMEN REQUIRED in London. State age, experience, and salary required.—Address, 7704, The Engineer Office. 7704 A

DRAUGHTSMAN REQUIRED, with Experience in the design of Plant for By-product Recovery, Tar Distillation, Oil Refining, &c.; Woolwich district.—Address, stating age, full particulars of experience, and wages required in confidence, 7681, The Engineer Office. 7681 A

DRAUGHTSMAN, Senior (for Birmingham). Having good experience Band Conveyors and Light Steel Structures. Must be competent prepare schemes, make all calculations, give quick accurate reliable work, supervise detailers and co-operate enthusiastically. Full particulars training, experience, posts held, salary required.—STEEL BELT CONVEYORS, Ltd., Norwich Union Chambers, Birmingham. 7680 A

Edward Arnold & Co.'s Book List.

New and Revised Edition.

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By J. S. S. BRAME, F.I.C., Professor of Chemistry, Royal Naval College, Greenwich.
Third Edition. 18s. net.

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80 pages. Demy 8vo. 7s. 6d. net.

Up to 2000 lbs. pressure and 400° F. superheat at intervals of 10° F. Arranged on a pressure basis with all the required properties on one page, instead of separate tables for total heat, entropy, volume, &c.

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New Book by the Author of "Metals and Metallic Compounds."

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THE MEASUREMENT OF FLUID VELOCITY AND PRESSURE.

By the late J. R. PANNELL, Senior Assistant in the Aero-dynamics Department of the National Physical Laboratory. Edited by R. A. FRAZER, B.A. (Cantab.), B.Sc. (Lond.). With Foreword by R. V. SOUTHWELL, Superintendent of the Aero-dynamics Department of the National Physical Laboratory. Demy 8vo. 10s. 6d. net.

STEAM POWER.

By W. E. DALBY, F.R.S., London University Professor of Engineering in the Imperial College of Science and Technology. Second Edition. xv + 760 pages, with 250 Diagrams. 25s. net.

The Times Engineering Supplement.—"Can be fully recommended not only as a work of reference, but also as a treatise that will enable the reader to gain a mastery over the subject."

London: EDWARD ARNOLD & CO., 41 and 43, Maddox Street, W. 1.

SITUATIONS OPEN (continued)

DRAUGHTSMEN REQUIRED, Experienced in Printing Press Work.—Write full particulars to R. HOE and CO., Ltd., Borough-road, London, S.E. 1. 7653 A

TOOL DESIGNER WANTED IMMEDIATELY, London district. Must have had first-class and up-to-date experience. Age between 28 and 40. Good position for right man.—Address age, experience, and salary required, 7683, The Engineer Office. 7683 A

SITUATIONS WANTED

ADVERTISER DESIRES MANAGERIAL POSITION in New Year; engineers' tools and supplies, ironfoundry and constructional steel work; take charge staff, correspondence, purchasing and sales; good technical knowledge; age 32.—Address, P9881, The Engineer Office. P9881 B

ADVERTISER, 14 Years' All-round Engineering experience, both technical and practical, desirous of change, SEEKS POST as TOOLROOM or MACHINE SHOP FOREMAN, SUPERINTENDENT, or other responsible position.—Address, P9868, The Engineer Office. P9868 B

A.M.I.C.E., Railway Locomotive Works, D.O., in charge of running sheds, automobile, general and civil experience, fully qualified, theoretically and practically, good organiser, used to control of large staffs, some commercial experience, DESIRES POST, moderate salary.—Address, P9882, The Engineer Office. P9882 B

CRANES, TRANSPORTERS, EXCAVATING, CONVEYING, MATERIALS HANDLING MACHINERY.—SPECIALIST in designing, estimating costs, sales correspondence, production, management, public school man, 20 years' live experience, SEEKS ENGAGEMENT, London preferred. Knowledge French, Spanish.—7, Upper Grove, South Norwood, London. P9858 B

ENGINEER—CIVIL (44)—SEEKS Active POSITION. Experience covers dock, harbour and river work, timber quays, factory buildings and reinforced concrete. Specialised in accurate levelling.—Address, P9861, The Engineer Office. P9861 B

ENGINEER OPEN for RE-ENGAGEMENT, Age 38, 16 years' first-class experience; rapid and economical production small to medium work, expert jigs, tools, layout and production methods, as WORKS MANAGER, PRODUCTION ENGINEER, TOOL SUPT., or similar post. First-class refs.—Address, P9860, The Engineer Office. P9860 B

ENGINEER (21) REQUIRES POSITION with prospects; cons. pratrd.; 5 yrs. apprentice in works with D.O. and com. office experience.—Address, P9856, The Engineer Office. P9856 B

ENGINEER (34), Practical, Technical and Commercial training, experienced complete industrial installations, SEEKS POST, D.O., erection, buying.—Address, P9862, The Engineer Office. P9862 B

ENGINEER, with 18 Years Modern Production, planning, shop, tool design, D.O., and organising experience, DESIRES APPOINTMENT offering scope; experience aero., automobile, instruments, press work, &c.—Address, P9854, The Engineer Office. P9854 B

ENGINEER, 1st Class B.O.T., Steady and Reliable, SEEKS PROGRESSIVE POST anywhere; able to control; works experience.—Address, P9876, The Engineer Office. P9876 B

ENGINEER (42), with Extensive Business, Financial, manufacturing and general experience, anxious to take advantage of prospective trade improvement, SEEKS APPOINTMENT with financial or merchant house or in other connection offering further scope for qualifications. Has successful record in responsible executive positions in export, also manufacturing business. Capable organiser negotiator, &c.—Address, 7655, The Engineer Office. 7655 B

IRON, STEEL AND ENGINEERING SALESMAN.—Mr. J. PILKINGTON HUNT, having completed six years' engagement with Messrs. Hall and Pickles, Ltd., is now OPEN to DISCUSS the REPRESENTATION of a high-class FIRM in the Manchester and Lancashire area.—Confidential communications to be addressed c.o. The Engineers' Club, Manchester. P9874 B

MECH. ENGINEER (22) DESIRES POST, where experience may be gained.—POTTER, 25, Jevington-gardens, Eastbourne. P9851 B

RESIDENT ENGINEER or CONTRACTORS' AGENT, POSITION WANTED as; roads, bridges, docks, railways.—Address, P9850, The Engineer Office. P9850 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

The Australian Cruisers.

IT is announced that ten British shipbuilding firms—four on the Tyne, four on the Clyde, one at Barrow and one at Belfast—have been invited by the Australian Government to tender for the construction of the two 10,000-ton cruisers, concerning which sharp discussion arose in the Commonwealth a month or two ago. The contracts, it is understood, will be placed early in the new year. Although at least one Australian tender is expected—that from the Commonwealth Shipping Board's dockyard at Cockatoo Island, the establishment responsible for the construction of the cruisers, Brisbane and Adelaide—it is thought to be practically certain that the order will be placed in this country. In that event the money saved will, it is believed, be expended on the construction in Australia of a floating dock and other equipment. It may be recalled that last August the position was that a British firm had offered to construct one of the cruisers for £2,100,000 with delivery in 27 months, or both for £2,050,000 each, with delivery of the second in 30 months. The estimated cost of building one of the cruisers in Australia varied from £3,300,000 to £3,960,000, and the period for delivery from 30 to 39 months. Thus if both cruisers are ordered in this country the Australian Government stands to save at least 2½ million sterling.

A New Trans-Atlantic Service.

THE announcement is made that a new joint passenger and cargo service between Germany and America is to be begun at the end of the present month. It is to be known, we note, by the somewhat unwieldy title of the American–Cunard–White Star–Hamburg–New York Joint Service, and will represent the combined interests of the hitherto separate services of the American Line, the Cunard and the White Star Line. The first sailing will be that of the American liner Mongolia from Hamburg on the 31st inst., followed by the Minnekahda of the same company on January 10th. The Cunarder Andania is scheduled to sail on January 27th, and will be followed by the White Star liner Arabic on February 7th, after which a regular service will be maintained. The steamers are to call at Southampton and Cherbourg and Halifax—for Canadian connections—on the western voyage, and at Cherbourg and Plymouth when east bound. This arrangement is to be varied by the Hamburg–American Line and the United American Lines, and it is expected that the liners of these companies will early in the coming year use Dover as the port of call for steamers on the New York run. It is thus possible that Dover Harbour, having been given over by the Admiralty, may again become an important centre for Transatlantic shipping.

A New Holt Liner.

A NEW passenger and cargo vessel, which next year will take up Alfred Holt and Co.'s service between Liverpool and the Dutch East Indies, was launched at the Greenock yard of Scott's Shipbuilding and Engineering Company, Limited, on Friday afternoon last. She is named the Polydorus, and is a medium sized ship of about 6300 gross tons with a length of 425ft., a breadth of 54ft. 6in., and a depth of 32ft. 9in. Geared turbines are to be used for propelling the ship, and they will be of the Brown-Curtis type with double reduction gearing. The two turbines are designed to develop about 3700 shaft horse-power and to run at 3420 and 2600 revolutions for the high-pressure and low-pressure units respectively. These speeds will be reduced by a specially designed three-box arrangement of gearing to the comparatively low propeller speed of 78 revolutions per minute on a single propeller. Steam is to be generated in two double-ended Scotch boilers fitted with Wallsend-Howden oil burning gear. A working pressure of 220 lb. per square inch will be employed, with 200 deg. Fah. of superheat obtained from superheaters of the smoke tube type.

The British Coasting Trade.

THE important subject of the future of the British coasting trade was dealt with by Sir Alfred Read in a paper on "Home Trade Transport by Sea," which he read before the Institute of Transport on Monday afternoon last. Sir Alfred pointed out that the war years had left an indelible mark on our coastal traffic. In 1913 something like twenty million tons of shipping was entered coastwise, whereas in 1920 the coast trade had dropped to about half that amount. To-day, with the increased competition of road and railway transport and with the prevailing trade depression, coasting shipping was fighting for its very existence. The nation, he thought, could ill afford to lose such a valuable system of transport, but if the coasting service of the country was to be developed to its fullest capacity, it must be cheapened and the co-operation of harbour and port authorities was essential to that end. There was ample room, Sir Alfred said, for improved shipping accommodation at most of our ports. Instead of single storied wooden erections, modern double-storied sheds with raised platforms and mechanical means for facilitating rapid loading and discharge were required. At the present time there was considerable loss which arose directly from port congestion. The motor ship had begun to displace the steamship, but there was little use in building faster vessels if the time saved on the voyage was lost in port by lack of facilities and the restrictions of shore labour.

The Wembley Exhibition of 1925.

THE prospects of unbroken representation on the part of India, the Dominions, the Crown Colonies and Possessions at Wembley next year have, it is said, been strengthened during the last few days. It is pretty certain, however, that the combined displays of specific industries will not be so prominent as they were this year. In the engineering and kindred industries, the general opinion seems to be that any further participation in the British Empire Exhibition should be left to individual enterprise. In the electrical industry, however, there is a movement on foot to try and arrange for leading firms in particular branches of the industry to combine and set up a representation of an electric town, which is to conform with a typical town of the future, when coal will have ceased to be used in its natural state for domestic and industrial purposes. While it can be taken for granted that the displays of heavy engineering plant in the Hall of Engineering will be on a less ambitious scale next summer than they were this year, it is expected that the engineering industries will be adequately represented.

Photographs by Wireless.

A FEW days ago photographs were successfully transmitted by wireless from London to New York. The transmissions took place from Radio House in the City and were received at the headquarters of the Radio Corporation of America. The system adopted was designed by Mr. R. H. Ranger, who has been working on the problem of transmitting photographs by wireless for two years. Experiments have so far been confined to a one-way transmission, and no pictures have been received in this country, but, according to messages which reached Radio House during the course of the recent demonstration, the photographs which were reproduced at the Radio Corporation's headquarters were quite good. Full technical details of the system employed are not yet available. It seems, however, that an ordinary photographic film is placed on a glass drum, which contains a bright light. The light shines through the film and impinges upon a lens which concentrates the light from a particular portion of the film upon a photo-electric cell. As the drum revolves, the light acts successively upon each part of the film, and affects the signals of an ordinary wireless transmitting circuit. At the receiving end the signals are made to actuate a pen, which makes marks on a drum similar to that at the transmitting end, and so reproduces the picture. The drum to which the photograph to be transmitted is attached is moved 1-128th part of an inch in each revolution, and the light passing down the photograph 128 times for each inch in the picture sends in effect a series of dots and dashes, which are utilised at the receiving end for reproducing the picture.

Quick Pipe Laying.

LAST week saw the completion of an expeditious job of pipe laying in the Midlands, when the Sheffield Gas Company completed its connection with the Handsworth, Woodhouse and Dronfield plants. It was only on August 7th that the Sheffield Company secured the necessary official permission, but the work of laying the connecting main was started on September 8th. In the interval there had been ordered and manufactured some 2860 yards of lap-welded steel pipe, 8in. in diameter, besides 5940 yards of 6in. pipe. When the actual work of laying the main was started considerable difficulties were experienced, as it had to run through very busy streets where the building line is on the roadway, and all the pipe joints had to be welded *in situ*. The whole work of laying five miles of pipe in a busy industrial district and within the space of approximately eleven weeks has, however, been concluded without any untoward incident.

The City Railway.

THE oldest tube railway in the world, and the first railway to be driven by electricity in England, the City and South London, has now completely changed its character and at the same time its name, for it is now known as the City Railway. Work on the enlargement of the tunnels has been going on for many months past, but has now been completed, and the first train under the new conditions made a trip on Monday last between Moorgate and Clapham Common. In the old days the tunnels were narrow, and the trains consisted originally of three very small and very stuffy compartments, padded from floor to ceiling, and with no side openings. Under the new conditions the trains conform to modern practice. The cars are all-steel, well lighted and well ventilated. Stations have been rebuilt, platforms have been lengthened, and escalators now take the place of some of the old staircases and lifts. In all respects the railway is now on a par with any other of the subterranean railways of London. Twenty-six trains are to run every hour between Clapham Common and Camden Town, thirteen between Headon and Edgware, and thirteen between Camden Town and Highgate. Furthermore, extensions are being made southwards from Clapham Common to Morden, which will give access to Balham, Tooting and Merton, and a junction with the Hampstead Tube is also being made. When completed, the total length will be 21¼ miles, and, as Lord Ashfield pointed out on Monday, it will be the longest railway tunnel in the world.

Another Yarrow Professor.

AT the anniversary meeting of the Royal Society on Monday last, Sir Charles Sherrington announced that a third research professorship had been provided from the gift of Sir Alfred Yarrow. To this professorship Professor O. W. Richardson has been appointed. Professor Richardson is best known for his work in relation to the emission of electrons from hot bodies. Referring to the appointment, Sir Charles Sherrington said that, like the other two Yarrow professors, Professor Richardson would continue to work in a laboratory from which he had already published a large part of his best work. It was reasonable to hope that the freedom from routine duties which would result from the new appointment would enable him to make a still greater output of research work; but since it was the desire of the Royal Society that their research professors should inspire the research work of others, arrangements had been made which would permit Professor Richardson to continue to supervise a certain amount of graduates' research work, and his success in guiding and stimulating the researches of others in the past led to the hope that such educational work might be by no means the least valuable part of his exertions in the future.

James Watt's Workshop.

FOR some time past it has been known by many, though perchance not by all, that a replica of James Watt's attic workshop in Heathfield Hall, at Handsworth, near Birmingham, is to be erected on the ground floor of the new Science Museum building at South Kensington, in close proximity to the two Boulton and Watt engines of 1788 and 1797. The fact is now made public property, and will be received with universal approval. There is no apartment in the world more famous in the history of industrial development than the attic in which James Watt spent much of the latter half of his life, and in which some of his inventions were developed. Whilst therefore we may rejoice that a replica of it is to be built in London, we cannot but feel the deepest regret that efforts made to preserve Heathfield Hall with this famous attic have failed, and that the old house will be pulled down when the estate, which has already been sold, is cut up for building purposes. We can, however, at least be happy that Major Gibson Watt has presented to the Science Museum the contents of the workshop. London will therefore have an opportunity of seeing arranged exactly as they were in their original positions and in facsimile surroundings the simple machine tools, the famous machines for copying carvings, the scanty furniture and the other contents of a chamber which has been the Mecca of all engineers for many years past.

Rejection of the Water-Bus Scheme.

ON Tuesday last the London County Council had before it for consideration the recommendations of the General Purposes and Highways Committee on the proposal made by Sir Samuel Instone for the provision of a fast motor boat service on the Thames. It will be recalled that Sir Samuel Instone offered to provide the boats and work the service if, on its side, the Council would provide pier accommodation. The recommendations were (*a*) that the Council was prepared to undertake the provision of piers to enable the passenger boat service or services on the Thames to be run by private enterprise if it can be shown that no portion of the expenditure incurred by the Council will fall on the County Fund; (*b*) that the Council is not prepared to undertake the provision of the necessary piers to enable a service of motor boats to be operated on the Thames on the lines of the scheme submitted by Sir Samuel Instone. The Council, however, further agreed that it was prepared to consider alternative proposals offering more satisfactory financial conditions. There was a good deal of discussion on the subject, and the recommendations of the General Purposes Committee were criticised pretty roundly, but a motion that recommendation (*a*) be referred back to the Committee was nevertheless defeated by 70 votes to 35. Hence it would appear that unless Sir Samuel Instone's company is prepared to accept the whole expenditure involved in the production of the boats and the provision of piers, the scheme for the establishment of a water-bus service on the river Thames will fall to the ground.

A New System of Main Line Electrification.

By L. DE VEREBELY, Consulting Engineer in Charge of the Electrification of the Hungarian State Railways.

One of the most interesting conclusions arrived at and expressed unanimously by some of the best-known English and American electrical experts at the first World Power Conference was, that in the future, when main line electrification is undertaken on a large scale, a system must be aimed at which will avoid the present necessity of using a special "railway current" and will enable the electrified railways to draw current directly, without the interposition of sub-stations equipped with converting machinery from any standard general power system.

Besides giving a higher efficiency and reducing the installation and distribution costs, the system meets two requirements which dominate power station economy. It enables large generating units to be employed and to be run at high load factor, which means that the current will be produced more cheaply. Advantageous load conditions can be obtained only by combining many consumers of quite diverse character into a common system, so that their various load curves overlap and produce a total load, which is fairly constant for twenty-four hours. In this way the production costs per unit of power will be lowered considerably, not only because of the higher efficiency and better overall economy of the power plant itself, but because the reserve equipment can be reduced and the overhead and capital charges of the power plant and of the whole transmission system will be distributed over a greater number of kilowatt-hours.

It follows that if the greatest possible economy is to be secured the erection of separate generating stations for the supply of electricity to railways should be avoided and all current, for traction and industrial purposes alike, should be generated on a standard basis. All power plants must generate the same kind of current, which, according to the present standards, is three-phase alternating current at 50 or 60 cycles, and the electric energy must be distributed by a common transmission system to all consumers. In the past this scheme for satisfying the power demands of electrified main lines has aroused much discussion, especially from the advocates of the existing alternating-current systems. The fluctuations of load and voltage, the poor load factor and the low power factor generally associated with the power demand of electrified railways, have been, and are still, considered by many experts to make the direct coupling of railway loads with industrial and lighting load undesirable. This idea has led and still leads to the erection of separate power stations, or at least of separate generating units and of separate transmission lines for railway purposes only. The single-phase system also involves the adoption of odd frequencies, such as 15–16⅔, as standards for main line electrification, and until recently all over the Continent of Europe low frequencies have been employed solely because the main driving motors—single-phase series and three-phase induction motors alike—used on electric main line locomotives required low frequency to work with satisfactory characteristics.

Close investigations embracing extensive main line systems—in case of the Hungarian State Railways about 900 miles in all—prove that the power demand of a number of properly selected and combined main lines, with traffic dense enough to make electrification justified from a financial point of view, would result in a load not less favourable to a power supply system than that imposed by heavy industrial districts. It might even become a very desirable day and night base load, when the capacity of the power supply is large enough to accept and to satisfy the electrified railway as a big consumer. Practical proof of this has been afforded by some important electrification schemes, such, for example, as the Philadelphia-Paoli and Chestnut Hill branch of the Pennsylvania Railway and the Chicago, Milwaukee and St. Paul Railway's transcontinental line. In the event of the connection of the railway load to the general supply system proving advantageous to the latter, certain fundamental requirements must be satisfied, besides a fair load factor, these being the absence of excessive peak loads and current rushes and the provision of a high power factor.

If in the case of extensive main line electrification carried out by means of a properly developed system there is no other objection to a common supply for the railways and the general consumers, the statement at the commencement of this article is justified. From the point of view of highest economy in the broadest sense of the word the best solution of the problem of main line electrification is to be found in a system which does not necessitate a special form of electric current generated in separate power plants or converted in sub-stations and transmitted over separate lines for the railways' own purposes exclusively, but which offers the possibility of connecting the railway load to any general standard power system with the least transformation, *i.e.*, with the highest overall efficiency.

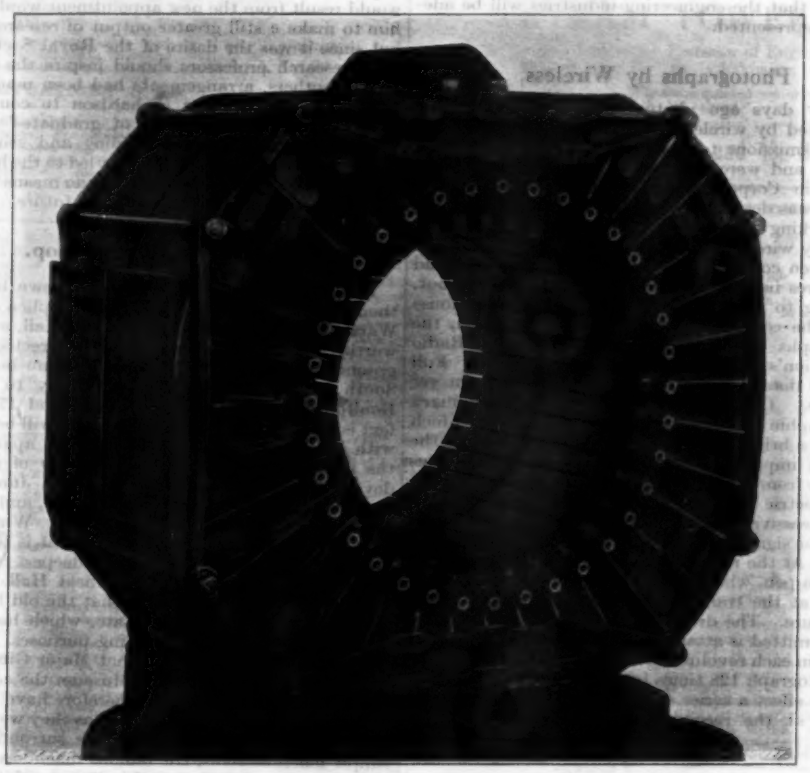


FIG. 1—STATOR OF PHASE CONVERTER

The truth and significance of this principle, which now seems to be recognised, even in countries possessing the most ample natural resources of energy, was clearly perceived and fully appreciated long ago in Hungary, where the critical conditions created by the war brought the extensive electrification of the Hungarian State Railways into the foreground. The problem of main line electrification in Hungary is of vital importance, and it has to be solved in spite of the many extremely adverse circumstances that now prevail.

The Treaty of Versailles deprived Hungary not only of two-thirds of its over a thousand years' old territory, but practically of all the natural resources of energy, which were primarily destined to be developed and organised into a large power system. Hungary has lost all its natural gas wells—the richest in the world next to the Pennsylvanians—94 per cent. of its water powers, 85 per cent. of its great forests, and out of its very modest stock of mineral fuels over 60 per cent. of the largest and best deposits. Within the new boundaries the production of useful power must rely almost exclusively upon deposits of mineral fuels, which are so limited, that if the present waste is not checked energetically will not last longer than about fifty to sixty years. About 40 per cent. of these fuels are of such low quality—lignites and peat, 4000–5000 B.Th.U. per pound—that they can scarcely be utilised to any greater extent and with economy under the present conditions of power production. Electrification carried out on a large scale can, however, help quite considerably in the way of improving this critical situation.

With regard to railway electrification, but little consideration is sufficient to show that none of the three alternative systems at present in use, viz., the single-phase, the three-phase and the high-tension direct-current system, meets the above fundamental requirements fully. The single-phase system, using series commutator motors of various types, is limited by the problem of commutation, which becomes critical when in goods service heavy trains have to be started and the locomotive has to develop full tractive effort at, or almost at, a standstill for a considerable length of time. The limit of highest feasible frequency seems to be reached with the 25 cycles standard in the United States. The three-phase system is handicapped by low power factor when the frequency is raised from 16⅔ to 50, though this difficulty could be partly overcome by using high-speed induction motors with a small number of poles and reduction gears. Thus, both systems using alternating current on the trolley, necessitate, when a power source of 50 frequency is at disposal, sub-stations with rotating machinery, just as the 3000-volt direct-current system,[1] which is also handicapped by its more sensitive commutators, special protective apparatus, and, so far as Hungary is concerned, by the relatively large amount of copper needed for its overhead construction.

In view of these facts and the economic conditions prevailing in Hungary during the first years after the war, it was not possible to commence railway electrification on a large scale, but experiments were, nevertheless, carried out with a view to developing a new system having the desired characteristics. The work was begun in 1917 by Dr. K. de Kandó, technical adviser of the Ganz Electric Company in Budapest, on the three-phase principle. The high-tension three-phase system, as used with great success on the electrified main lines of the Italian State Railways, was developed according to his designs,[2] and the very simple and powerful three-phase locomotives possess some very desirable characteristics.

As already explained, however, the direct-driving three-phase induction motor, whose speed is limited to a relatively low value by the speed of the locomotive and the usual diameters of the driving wheels, is undesirable on account of the poor power factor and bad efficiency at light loads, and low overload capacity, when used on 50-cycle circuits. Theoretical investigation revealed the fact, however, that slow-speed induction motors, with good characteristics over a large range of output, as required in traction service, might be built for high frequency, if the standard method of feeding the motors with constant pressure is abandoned and the voltage applied is varied in accordance with the load, following a definite law.

This law, which has been fully described in a paper presented by the author before the First World Power Conference,[3] can be expressed by the formula:—

$$E = a\sqrt{W} \quad . \quad . \quad . \quad . \quad (1)$$

The law shows that as long as the iron core is below saturation, an induction motor will run throughout the whole range of its capacity with the highest possible constant efficiency, if the pressure applied varies proportionally to the square root of the input (or output).

The most simple scheme for meeting this requirement would be to place a rotating auxiliary machine—say, a motor generator—on the locomotive, to run it by the current drawn from the trolley and to vary the field excitation of the generator side by means of an automatic regulator in such manner as to obtain a pressure for the main motors that follows the law stated. A very similar scheme is to use an auxiliary machine for phase transformation, *i.e.*, to build the motor as single-phase motor for 50-cycle single-phase current, leaving a generator to deliver three-phase current to the motors. With this scheme the only serious drawback of the three-phase system, namely, the necessity of using two independent and insulated overhead wires over each track, could be eliminated, and the excellent characteristics of the simple and robust three-phase locomotives could be combined with the very simple, safe and cheap trolley system as used for single-phase operation. Another very important advantage might be obtained by making the single-phase motor a synchronous machine, in which case, by proper regulation of its direct-current excitation, unity or any desired power factor could be maintained automatically in the primary circuit. Naturally, the direct-current field excitation of the motor and of the generator ought to be varied inde-

[1] We should not consider it advantageous under the traffic conditions prevailing on our main lines to use a lower pressure on the trolley.

[2] The total equipment of the pioneer Valtellina Line was designed and manufactured in Hungary by the Ganz Electric Company and the Hungarian State Machine Works, both in Budapest.

[3] L. de Verebély, "A New System for Main-line Electrification," "Transactions," W.P.C., Section K, No. 345.

pendently, according to the separate specific requirements imposed on the two machines.

Though the possibility of obtaining these advantages would perfectly justify the use of an ordinary motor generator, it is evident that the efficiency could be raised, and weight, price and maintenance of the locomotive could be reduced considerably, if the two machines could be combined into one. The ingenious solution of this problem is one of the characteristic features of the new system.

The motor and generator united into one machine is called a phase converter, which has on its stationary element two entirely separate windings; a single-phase or primary winding, connected directly between the trolley and earth (rails), and a three-phase, or secondary winding, connected to the locomotive motor circuit. The three-phase winding is distributed uniformly on the whole circumference, whereas the single-phase winding occupies only two-thirds of it. The revolving part, excited with direct current and running at synchronous speed, is common to both. If in this machine the excitation is varied so that the pressure delivered by the three-phase winding to the locomotive motors varies according to the law $E = a\sqrt{W}$, it is evident that in the absence of suitable arrangements the voltage induced in the single-phase winding would vary also. The trolley voltage being constant, the external effect of this variation has to be suppressed, and this can be accomplished either by connecting an inductance

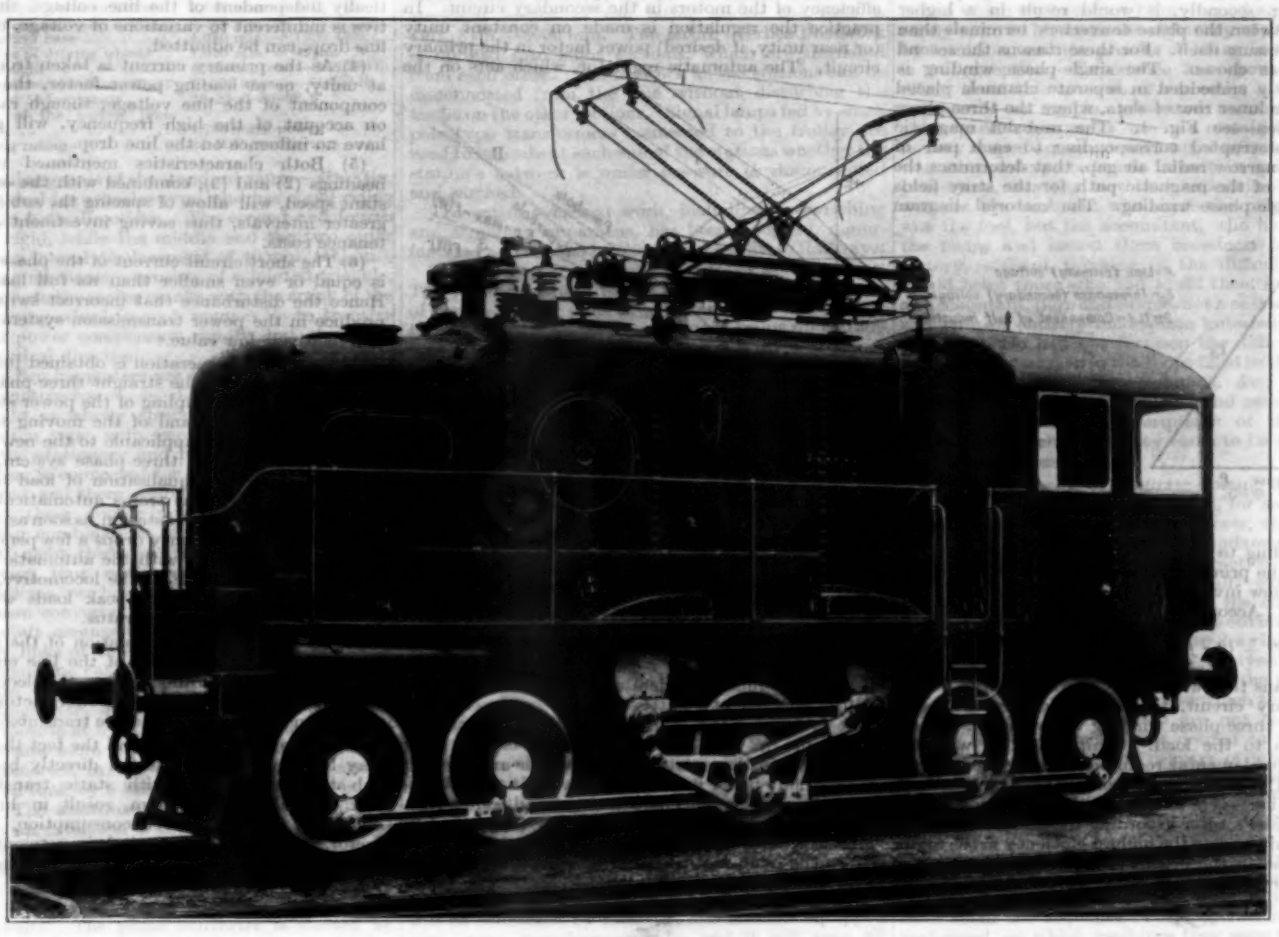


FIG. 2—EXPERIMENTAL LOCOMOTIVE EQUIPPED WITH PHASE CONVERTER

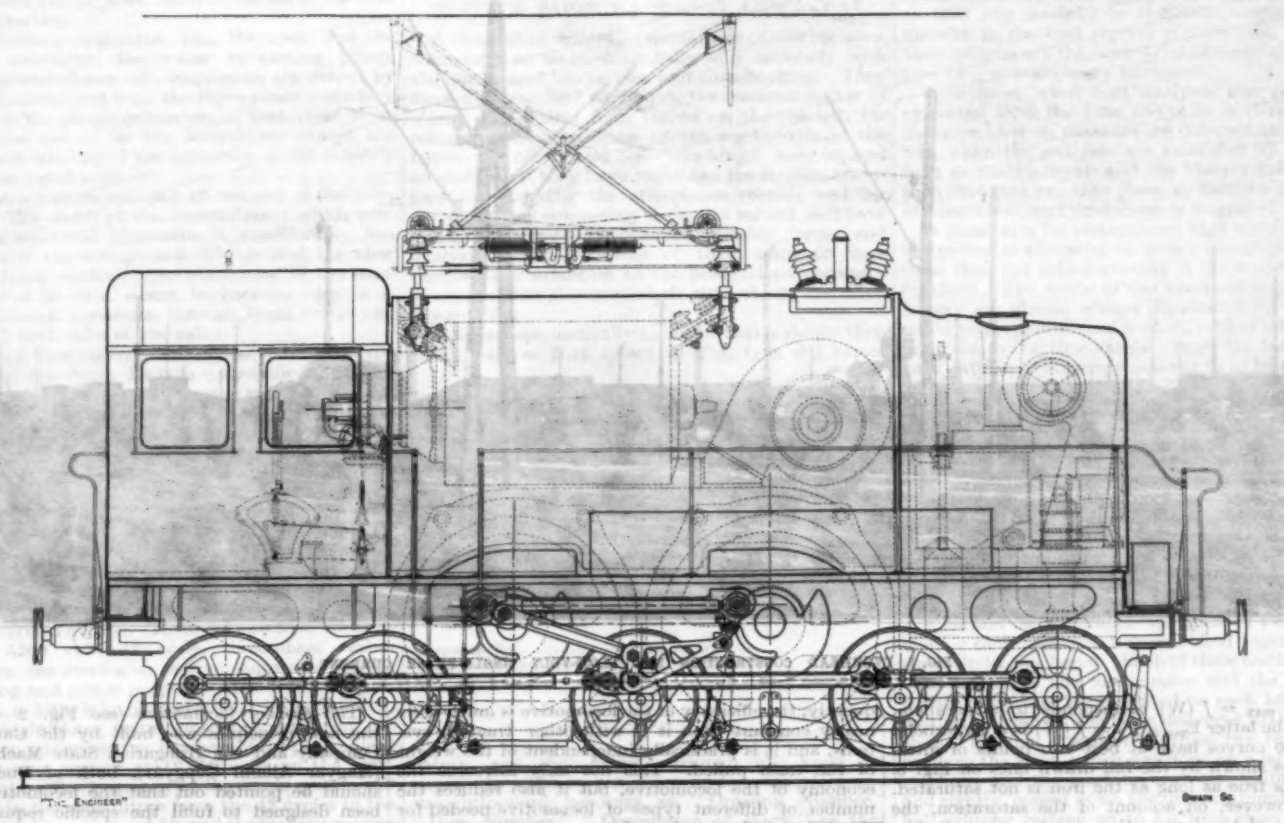


FIG. 3—ARRANGEMENT OF PHASE CONVERTER LOCOMOTIVE

in series with the single-phase winding or by arranging the two windings in such manner as to obtain a strong stray flux between primary and secondary. The first solution would have two drawbacks. First, the choke coil would be a cumbersome and expensive apparatus; secondly, it would result in a higher tension between the phase converters terminals than the line pressure itself. For these reasons the second method was chosen. The single-phase winding is consequently embedded in separate channels placed outside the inner row of slots, where the three-phase winding lies—see Fig. 1. The mid-slot magnetic path is interrupted corresponding to each pair of slots by a narrow radial air gap, that determines the reluctance of the magnetic path for the stray fields of the single-phase winding. The vectorial diagram

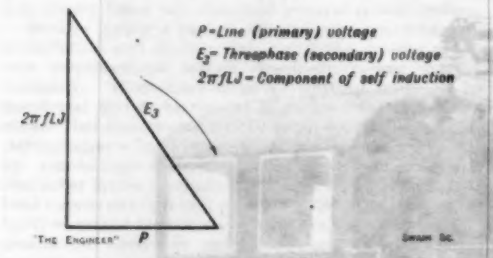


FIG. 4

corresponding to this scheme and with unity power factor in the primary circuit, is shown in Fig. 4.

Let us now investigate the behaviour of this phase converter. According to the vector triangle:—

$$E_s^2 = P^2 + (2\pi f L J)^2 = P^2 + \left(2\pi f L \frac{W}{P}\right)^2 \quad (2)$$

which means that when unity power factor is held in the primary circuit, the voltage generated in the secondary three-phase winding will vary in a certain proportion to the load. Comparing this with the previous fundamental requirement expressed by the formula (1) it is at once evident that the two methods of regulation—*i.e.*, to change the excitation of the phase divider's rotor according to the law of holding constant in one case the highest efficiency in the motor circuit, and in the other case unity power factor in the primary circuit—do not coincide. In the former case $E_{\eta\,max} = f(W)$ corresponds to a parabola, whereas the latter $E_{\cos\varphi\,=\,1} = f(W)$ is a hyperbola. These two curves have at best two points of intersection, as shown by the full drawn lines on Fig. 6. This holds true as long as the iron is not saturated. When, however, on account of the saturation, the reluctance of the iron path is no longer negligible, as compared to the reluctance of the radial air gaps, the upper part of the $E_{\cos\varphi\,=\,1}$ curve bends down, and may intersect the $E_{\eta\,=\,max}$ curve for the third time, as shown by the dotted lines on Fig. 6. Hence, with a properly designed mid-slot magnetic path, the two actual regulation curves will interlace with each other, which means that the phase converter can be made to fulfil simultaneously, and with sufficient accuracy between wide variations of load, both requirements, namely, to maintain unity power factor in the primary and to deliver a pressure corresponding to the highest efficiency of the motors in the secondary circuit. In practice the regulation is made on constant unity (or near unity, if desired) power factor in the primary circuit. The automatic regulator, which acts on the

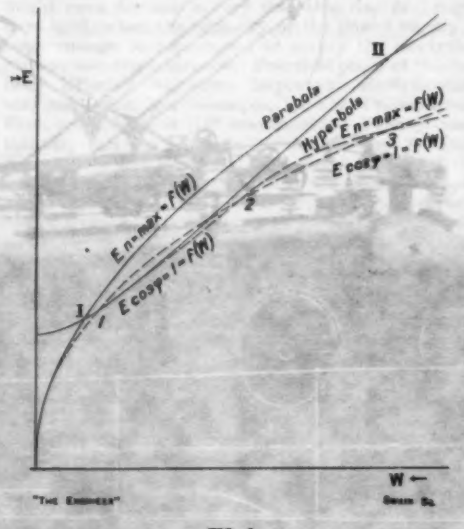


FIG. 6

field of the phase dividers exciter machine, is built on the principle of a wattless meter.

It is beyond the scope of the present article to enter into all the theoretical details of the phase converter, further particulars of which are given in the author's paper mentioned above. It must suffice to sum up the general characteristics and main advantages of the new system, as shown by theory and by practice.

(1) The main motors work between wide ranges of load at the highest obtainable efficiency. Consequently, the efficiency of the locomotive is much more nearly constant than it is with other traction systems, and it is practically independent of the weight of the train pulled. This not only increases the economy of the locomotive, but it also reduces the number of different types of locomotive needed for the different classes of service.

(2) The independence of the motor power factor from the line power factor makes it possible to use slow-speed induction motors with all the advantages of direct drive. Further, it allows special design and better utilisation of the active material, resulting in lighter motors for a given capacity. In this way the additional weight of the phase converter[4] is partly equalised, as shown by the exceptional high specific rating obtained in the experimental locomotive—34 horse-power per metric ton.

(3) The pressure applied to the motors being practically independent of the line voltage, the locomotive is indifferent to variations of voltage, thus larger line drops can be admitted.

(4) As the primary current is taken from the line at unity, or at leading power factor, the inductive component of the line voltage, though rather large on account of the high frequency, will practically have no influence on the line drop.

(5) Both characteristics mentioned under the headings (2) and (3), combined with the one of constant speed, will allow of spacing the sub-stations at greater intervals, thus saving investment and maintenance costs.

(6) The short circuit current of the phase converter is equal or even smaller than its full load current. Hence the disturbance that incorrect switching may produce in the power transmission system is limited to a relatively low value.

(7) As power regeneration is obtained just as automatically as it is in the straight three-phase system, the elastic electric coupling of the power station with all trains in motion and of the moving trains with each other is just as applicable to the new system as it is to the ordinary three-phase system. In consequence, a certain equalisation of load takes place within the system, the trains automatically helping each other and the power station, as soon as, on account of overload, the frequency drops a few per cent. This feature, in connection with the automatic regulation of the starting rheostat of the locomotive, results in smoothing down excessive peak loads without the aid of special limiting apparatus.

(8) As the automatic regulation of the phase converters will hold the phase of the line current constant at any predetermined value, the electric railway might be used to correct the power factor, not only of his own load, but of the whole transmission system.

(9) These characteristics and the fact that the railway load might be connected directly by means of sub-stations equipped with static transformers to any general power system, result in high overall efficiency, reduced power consumption, good load factor, and hence less capital investment, and less working and maintenance expenses, as compared with any other system of electrification.

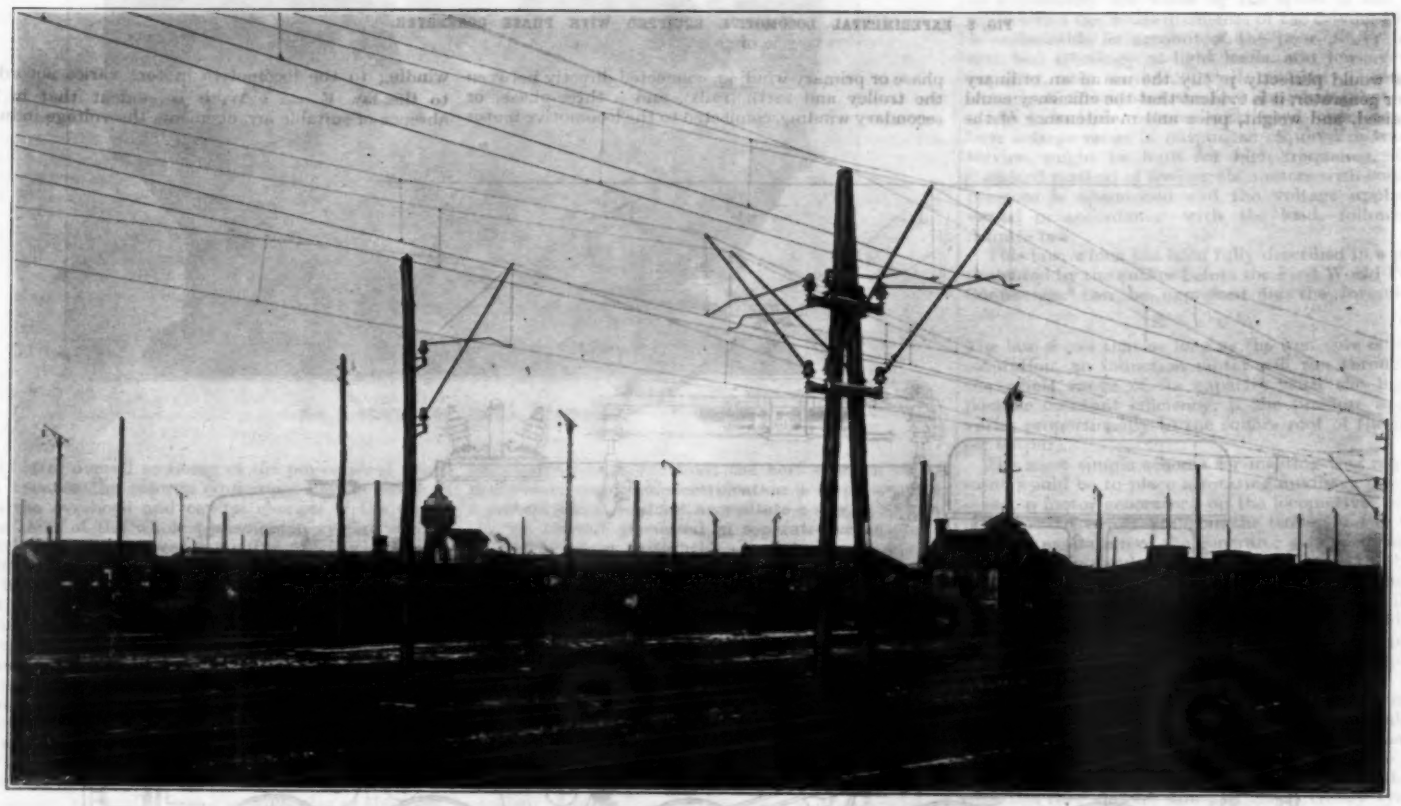


FIG. 5—OVERHEAD CONSTRUCTION FOR 12,000-VOLT SINGLE-PHASE CURRENT

The pioneer locomotive—see Fig. 2—embodying the new principles was built by the Ganz Electric Company and the Hungarian State Machine Works (Magyar Allami Gépgyár), both of Budapest. It should be pointed out that the locomotive has not been designed to fulfil the specific requirements of any given railway line, and to meet certain definite traffic conditions, nor is it to be regarded as a standard type of machine. It was built purely for experiment

[4] The weight of the phase converter is a surplus weight when comparison is made with a plain three-phase locomotive. Compared with single-phase equipment, the phase converter might correspond to the transformer.

on a large scale in order to obtain correct answers to certain fundamental questions.

The principal dimensions and data of the locomotive are as follows :—

Axle arrangement	O–E–O
Total length between buffers	9,640 mm. = 31ft. 7⅛in.
Total wheel base	6,580 mm. = 21ft. 7¹⁵/₁₆in.
Rigid wheel base	4,080 mm. = 13ft. 4⅝in.
Diameter of driving wheels ..	1,070 mm. = 42⅛in.
Total weight	80 metric tons = 176,300 lb.
Starting tractive effort, about	20,000 kilos. = 44,000 lb.
Speeds at 50 frequency ..	25–33.3–50–66.6
Rating of the motors (one hour)	2,700 horse-power
Specifing rating	34 H.P./metric ton

The running gear is of the standard gauge—4ft. 8½in.—symmetrical ten-wheeler type, and has equal riding qualities in both directions. The second and fourth axles are rigid, while the middle and the two outer axles have a lateral displacement of 40 mm. (1⁹/₁₆in.). The driving mechanism consists of a jointed triangle, which connects the motor cranks with the crank of the middle driving wheel in such manner as to transfer horizontal power components rigidly, but gives free play in vertical direction.

The two driving motors are mounted rigidly on the main locomotive frame—as shown in Fig. 3—so that their weight is wholly spring-borne. They are of the induction type, with two independent windings on both the stationary and on the revolving parts. One winding is connected for eighteen and the other for six poles, and there are only three slip rings. By connecting these double motors in cascade or in parallel four combinations are obtained, corresponding to forty-eight, thirty-six, twenty-four and eighteen poles, giving four synchronous speeds, 25, 33.3, 50, 66.6 kiloms. per hour at 50 cycles.

The phase converter is placed above the motors, with its shaft arranged longitudinally, and is suspended by links at three points from reinforced ribs of the locomotive cab. In construction it resembles a two-pole turbo-generator, having two independent windings on the stator and running at 3000 revolutions per minute at 50 cycles. For the sake of better insulation and more efficient cooling, the stationary part is immersed in oil, the rotor being separated from the oil tank by a bakelite cylinder placed in the air gap. The armature of the four-pole exciter is carried by an extension of the main shaft.

The automatic regulator varies the excitation so as to maintain a unity or a 0.95 leading power factor in the primary circuit, while the pressure delivered to the main motors is varied between 350 and 600 volts. The phase converter is started by means of storage batteries, using the exciter as driving motor. The batteries are charged from the exciter when standing in stations.

All connections in the motor circuit are made by the main controller, composed of ten three-pole unit switches placed in a row and driven mechanically by means of a cam shaft which is turned by a vertical lever. This lever also serves to extend the spring that governs the air inlet valve of the water rheostat used for starting.

The auxiliary apparatus, viz., the main and the rheostat ventilator, the water circulating pump, and the Westinghouse air compressor, are driven by induction motors fed from the three-phase secondary winding of the phase converter, so that there is no high-tension circuit in the locomotive except the single-phase winding of the converter, which is safely enclosed in its oil tank.

There is a motorman's cab at one end of the locomotive. The width of the compartment which contains the electrical apparatus is considerably less than that of the motorman's cab, so that the view from the front windows is not obstructed to the same extent as it is on a steam locomotive. Access is obtained to all apparatus through large ventilating louvres on both sides of the cab.

To give a thoroughly practical test to the new type locomotive the State Railways electrified 9½ miles on the former Budapest-Pozsony-Vienna main line, between Budapest West Station and Alag. The section is a first-class double-track line with maximum gradients of 3.6 in 1000. The total length of single track equipped with overhead construction amounts to 25 miles, so that all regular train movements can be accomplished by the electric locomotive. The traffic is composed of suburban passenger and goods trains.

Electric power is obtained from the small central station of the State Railways main repair shop at Istvántelek, situated approximately in the middle of the electrified section. There are two 3500 kilovolt-ampère, 5200 volt, 42 cycle, three-phase turbo-generators, one serving as reserve, supplying current for lighting and power purposes. The trolley system is fed by a 1000 kilovolt-ampère oil insulated, self-cooled, single-phase transformer connected on the low-tension side across two bus-bars of the power plant and delivering current at 12,600 volts on the high-tension side. The frequency of the whole system will be raised in the near future from the 42 cycles to the new standard frequency of 50, and the trolley pressure is to be raised from 12,600 volts to a pressure of 15,000 volts, which is to be the standard pressure for the Hungarian main line railways.

The overhead construction—see Fig. 5—is of the single catenary type, held by very light steel brackets insulated by petticoat porcelain insulators and mounted on wooden poles with an average spacing of 164ft. With regard to the experimental character of the whole installation, the galvanised steel messenger wire has a diameter of only 0.236in.—6 mm.—and the hard drawn copper trolley wire a cross section of 0.124 sq. in.—80 square mm. The standard height of the latter above the rails is 19ft. 8½in.—6000 mm. The entire overhead network is divided into eight sections, which are insulated from each other. The network at the stations can be disconnected from the line without disturbing the traffic on the other sections. Signal lamps fed by small pole type transformers connected to the trolley are used to indicate at each end of the stations whether the station's network is under pressure or disconnected and earthed.

The entire overhead work, including all switching and signalling apparatus, has been designed, manufactured and erected by the staff of the State Railways.

The practical tests began on October 31st last year. The locomotive was tested under various conditions of traffic, pulling passenger trains of 300–400 metric tons at the highest speed, and goods trains up to 1300 tons at 42 kiloms. per hour. It is too early to give a final report of the results obtained, but it can be safely stated that, in spite of the fact that the basic principle is new and all the details are of original construction, no serious difficulties have been encountered as yet and all the principal parts of the new equipment have given entire satisfaction. An important fact that should be recorded is that the comparatively small three-phase power station is not disturbed in any way by the single-phase railway load. The light and industrial power load amounts normally to about 1300–1600 kilovolt-ampères, with a power factor around 0.6. The railway load changes between 400–800 kilowatts, with peaks as high as 1200 kilowatts, at a power factor of unity or 0.95 leading. The dissimmetry and the voltage drop produced by the single-phase railway load are negligible and the power factor of the whole system is raised.

In the event of more extensive electrification the railway load will be much more uniform, because the traffic will be more dense. By proper sectionalising the electrified zone the load can be well distributed on the three phases of the standard power system, and all industrial three-phase motors connected to the same system will act as phase balancers which will tend to balance the system as a whole.

The electrified railway with standard current on its overhead trolley system will fit systematically into the general power system of the country, to which it will be connected by means of sub-stations equipped with static transformers only, and it will reap all technical and financial advantages of an adequate and reliable source of cheap electric power.

Costing and Time-booking.

By F. A. R. PATON, M.A. (Cantab.), A.C.W.A., F.S.S.

A NUMBER of writers on the subject of costing have, from time to time, dealt fully and faithfully with the question of labour cost and time-booking. They have all described at length the various forms of clocks which have been placed on the market, for recording the attendance of the workpeople in the factory or office, and for "clocking" men on and off each job; they have explained the routine necessary for checking the attendance records and for extending and computing the wages earned, and have given numerous examples of suitable forms and analysis sheets, but none of them seem to have devoted any attention to the precautions necessary to ensure that the employee's time sheets are filled in correctly.

It is perhaps naturally assumed that a simple time sheet, such as that shown in Fig. 1, is self explanatory, and that every workman will know instinctively what to put down under such plain and straightforward headings as "Drawing Number," "Item Number," "Description of Work," or that the clerk, whose duty it is to fill in the workmen's time sheets for them, will have no difficulty in putting down what is wanted in each column. It certainly would, at first sight, appear that there should be no difficulty in filling in such a form, and the "Accountant" who designed the time

Department..... *Order No*.....

TIME SHEET.

Name..... *Clock No*..... *Machine No*.....

Date.	Drawing No.	Item or Casting No.	Quantity Complete.	Description of Work.	Time Taken. Hours.	Min.

	£	s.	d.
Bonus			
Piecework No..... Nat. Award			
„ Price..... P.W. Time Rate ..			
Total			

FIG. 1

sheet would not be thought unduly harsh in voting the man a fool who could not fill in this form. But, somehow or other, there are always half-a-dozen wrong ways of doing a thing for every right way, and human nature seems to delight in causing us to hit upon the wrong way when there is one which we have not been warned against. We rarely seem to hit upon the right way of doing things by intuition, and the process of filling in time sheets is no exception. Experience has shown that the filling in of this time sheet correctly, an operation apparently so simple, presented innumerable difficulties, and a few weeks' use in a certain engineering factory reaped an enormous crop of mistakes. What was more unexpected and, in certain quarters, disconcerting, was the fact that experience showed it was not the workman who made the mistakes, that was the fool, but the accountant, who had designed the forms and issued them broadcast around the factory, without thinking of the difficulties which would beset those who had to fill them in. He was an accountant, pure and simple, not a cost accountant, and had an entirely inadequate knowledge of shop practice. He had not foreseen the difficulties that arose. The workmen in the shops filled in the drawing number and description columns, &c., but filled them in with the wrong numbers and gave incorrect, or rather alternative descriptions of their work, for reasons which, when they came to be considered, were perfectly justifiable.

The whole success of accurate costing depends on the correct filling in of time sheets, for so much use is, or should be, made of time sheets, that it is of the utmost importance that this fundamental source of information regarding shop practice should be complete, concise, and, above all, exact. Time sheets may primarily be used for the computation of wages; that is their first and most obvious purpose, but this does not entail reference to drawing numbers. Afterwards, however, they are analysed and the labour cost has to be distributed to the orders, job numbers and drawing numbers to which they purport to refer. If the time sheets are not correct, this cannot be done. When it is desired to investigate the cost of some machine or part of a machine in detail, either for the guidance of estimators, or to discover the reason for excessive expenditure, these time sheets have to be relied upon to reconstruct what actually took place in the shops. It must, therefore, be possible to pick out quickly all those sheets relevant to the part under review and only those relevant, and it must be possible to discover from them the sequence of the operations actually performed, on which machines they were performed, by which workman, and, above all, it must be possible to detect extra or repeat operations for rectification of defects and other unusual occurrences.

The parts played by time sheets in costing and factory control are legion, and, though so little attention is paid to their correct compilation, they are fundamental; they are the beginning of all things in costing and factory control through costing, so that any mistake in the time sheets means a mistake in the cost reports and returns, and when these returns are the summaries of many time sheets, they may contain many mistakes.

Sometimes, when cost analyses and reports are extracted from the time sheets by a clerk, some of the more obvious mistakes are detected and rectified, but, when the analyses are extracted by machines, such as the Hollerith and the Powers machines, no such detection can take place, so that the importance of ensuring correct time sheets is magnified.

It must also be remembered that time sheets are the means of allocating to orders considerably larger sums than the actual amount of the wages extended on them. The whole of the overhead expenses of a factory are almost always distributed on a basis of either wages paid or time worked, both of which figures originate in the time sheets. Since the factory overhead expenses commonly amount to at least as much as the wages bill, and since the two together often represent between 60 and 70 per cent. of the total cost of production, a heavy responsibility falls on those whose duty it is to see that time sheets are filled in accurately.

Every error in the time sheets becomes doubled upon its inclusion in the cost sheet of the order.

In what follows there are enumerated some of the mistakes which were actually made by workmen in the shops in filling in their time sheets, and the remedies which were devised by a cost consultant for preventing their recurrence.

A certain large cylinder was made of two castings, one for each half, which were bolted together before the cylinder was bored. Each of these castings had its own drawing. The job number and the respective drawing numbers were painted on each half-cylinder casting, as soon as they were delivered to the machine shop. The first operation on these two castings was to plane the joint, which was done on a large planing machine, and the machine operator, quite naturally and rightly, copied down the drawing number of each half-cylinder casting on to his time sheet as he did the job. He filled in two time sheets, one for each half-cylinder, so that work on each was booked under its own drawing number. The next operation was to drill the flanges, so that the two half-cylinders could be bolted together. Here again, the driller, quite naturally and quite rightly, copied out the drawing

numbers painted on the casting, as he finished the drilling, and he, too, sent in two tickets, just as the planing machine operator had done.

Cranes were then employed to place the two half-cylinders together, ready for fitting the bolts. The fitters who put these bolts in again filled in their time sheets by copying down the drawing number painted on the casting, but it so happened that one number was underneath and not noticed, so the whole of the fitters' time was booked to one half. Actual drawings were not required for this operation. The cylinder was now moved again by crane, in one piece, on to a boring machine, where the cylinder was bored out and the ends faced up. For this operation the machine operator required both the drawings, and he filled in his time sheet with both drawing numbers. The Hollerith cards, however, only had space for punching one drawing number, so the girls who punched the cards chose the first, which happened to be the one obscured when the fitters bolted the two halves together.

Shortly afterwards, it became necessary to investigate the cost of these two half-cylinders, and an extract of the analysis appeared as follows :—

		Hours. &c.
Dwg. 27542.	Bottom Half-cylinder.	
	Plane joint.	—
	Drill bolt holes.	—
	Bore and face.	—
	&c.	
Dwg. 27543.	Top Half-cylinder.	
	Plane joint.	—
	Drill bolt holes.	—
	Fit bolts.	—
	&c.	

To anyone familiar with the processes and operations necessary for machining a cylinder of this sort, it is, of course, obvious that the "Fit bolts" and "Bore and face" were operations performed on the cylinder after the two halves had been placed together, but there was nothing in the time sheets to show this, and it is the exception to find a clerk in the cost office capable of reconstructing an intelligible analysis, showing exactly what did happen in such a case. There are three chief reasons why it is necessary to have time booked so that it will be possible to interpret from the time sheets how much work was done on the two half-cylinder castings respectively, up to the point where their separate existence ceased, and how much work was done after the two halves were bolted together. They may be enumerated as follows :—

(*a*) Comparison.
(*b*) Replacements.
(*c*) Defective work.

(*a*) Comparison is one of the most potent instruments for cost control in a factory. It is desirable that comparisons of the cost of two similar castings (for different orders) should be possible, operation for operation, and this object can only be attained by ensuring that the machine operators book their time consistently. If they book their time to a certain drawing for the first casting, they must book their time to the same drawing, when next they are given this operation to perform.

(*b*) When replacements are ordered, a true price can only be given if the weight of the casting and the time taken on all the operations for the original order are known with accuracy. Furthermore, the operations on the casting itself, as distinct from those entailed in fitting other parts on to it or machining it in conjunction with other parts, must be easily segregable. It is always useful to have a possible replacement in mind, when attempting to decide how to book time on a certain operation.

(*c*) Similarly with the defective work, it is customary to credit the order with the cost of operations up to the point where the defect was discovered, and to charge it to a separate defective account. For this to be done accurately, it must be possible to distinguish operations performed on the scrapped casting alone, as distinct from those performed simultaneously on it and another, and so on.

How, then, is it possible to regulate the booking of time on time sheets, so that confusion will be avoided and the desired objects achieved ?

Much of the trouble in the factory from which this illustration is chosen arose from the fact that drawing numbers were painted on the castings. There was no particular reason for doing this, except that it was thought that they would be convenient for the men to book their time. That was just the trouble ; they were much too convenient, and any man who happened to be working in the vicinity of any of these numbered castings concluded that this drawing number was the one he was intended to book, so down it went on his time sheet. One case was discovered where no less than sixty-three different operations on twenty-four different parts, representing work valued at £325 3s. 8d., had all been booked to one of these prominently painted numbers !

The first step taken by the cost consultant was to stop this practice of painting drawing numbers in prominent positions on castings, and to make use of some labels, with which every casting was already provided, on which were written the order number, drawing number, name of casting or piece, &c. On the back of these labels, space was provided for the inspectors to note down each completed operation as they passed it, together with the date and their initials. It was a very simple matter to arrange for the drawing-office to fill in the backs of these labels before they were sent into the shops with a full list of the operations to be performed and the drawing number to which time was to be booked, unless it happened to be the same as that on the front of the label. By this simple means, the accuracy of time booking in the factory was increased enormously, and the inspectors were saved some clerical labour.

Often, one drawing is sufficient to show both the top and the bottom halves of a cylinder, but, in the case of large cylinders, such as the one referred to in this example, it is the practice to have two separate drawings, one for each half. To provide for time booking, in such cases, it was arranged to issue a third number, from the drawing number series, which would serve for time booking, from the moment when the two half-cylinders entered the manufacturing process as one piece. No actual drawing bearing this number existed, however.

Another class of machining operation which caused a crop of time booking mistakes was the machining of small parts for various sub-assemblies. For instance, a stop valve cover and details had a sub-assembly drawing numbered 27821, on which were shown, assembled together, the following parts :—

1	Main Stop Valve Cover	Drawing No. 27421
1	Valve Spindle	,,
1	Cast Iron Distance Piece	,, 27422
1	¼in. Air Valve	,, 23842
1	Collar..	,, 24938
1	Bronze Distance Piece	,, 27431

This sub-assembly drawing 27821, it is seen, included a number of small parts, many of which had their own drawing numbers ; but these, since the parts were also used on other sub-assemblies, had no connection whatsoever with the number 27821 ; but the labels which were tied to the castings or raw material handed out to the shop, had to have both the sub-assembly drawing number 27821 and the other number, *e.g.*, 27421 for the main stop valve cover, written on it, the former for the information of the erectors and the latter for the machine operators.

It consequently happened that some machine operators used to write both numbers on their time sheets, others chose one of the two, some one, some the other. They had never been told which was the correct one for them to put on their time sheets.

So long as the distance piece 27422, for instance, remained unattached to the stop valve cover the proper number for the "Turn and Bore," "Mark off," and "Drill" operations to be booked to was clearly 27422, the drawing used by the workmen for these three operations. There was no need for them to quote the sub-assembly drawing 27821 at all, for the cost clerks could easily locate the part to its correct sub-assembly by reference to the material specification belonging to the order.

After some investigation this reasoning led to the formulation of the following rule for the booking of time spent for machining operations on small parts.

"All machine operators will book their time to the drawing number showing only the part on which they are working. No time booked to sub-assembly drawings, without special permission, will be paid for."

To decide how fitters should book their time was a more difficult matter, chiefly because a considerable portion of the fitters' work in assembling small parts and in the general erection of complete machines was performed without drawings at all, and it was difficult to know how they could be expected to find drawing numbers to put on their time sheets. When left to their own devices they did, of course, find a drawing number to put down, but it seldom had any relation to the work they were actually doing and gave no help whatsoever to the cost clerk in attempting to make analyses of cost.

Bearing in mind the possibility of orders being received for spare parts, on which little or no fitting is done, except on the customer's premises, it was at once evident that the cost of fitting must be kept distinct from the cost of machining. That is the first consideration when attempting to determine a basis for time booking for fitting.

The next consideration was the fact that much of the work of the fitter consists of a number of jobs of short duration. He may spend twenty minutes radiusing corners or cleaning up a casting, then he taps a few holes, fits some studs, reamers out a hole for a bush, packs a gland, all in the course of an hour or two, which means that he may handle and work on half-a-dozen or more small parts, all having their separate drawing numbers. That he should be expected to fill up a time sheet for each of these operations and hunt out the proper drawing number of each would clearly be unthinkable.

Sometimes he gets longer jobs to do. He may spend a day or more chipping out flaws in steel castings, or he may be given the job of lining out a set of bearings and bedding the shaft, which may take him a couple of days. He could quite well fill in a time sheet for jobs of this sort, but what drawing numbers ought he to put down for the latter job—lining out bearings, for instance ? Neither the shaft nor the bearings nor the bearing pedestal drawing number would really meet the case, and in any event he would not need any of these drawings for his job.

After carefully weighing up the facts of the case it was decided to instruct fitters not to book their time to existing drawing numbers at all, but to arrange a special series of numbers for "General Assembly" to cover all fitting work. Fitters thenceforward inserted this number in the drawing number column on their time sheets.

The fitting and erection operations which were of long duration and which were distinct in themselves, such as lining out bearings, were each given their own number in the general assembly series, and a card displaying these numbers was hung up in the erection bay. Some of them were as follows :—

100	General Assembly (if not specified below).
101	Drilling and Reamering for Dowels.
102	Valve Assembly.
103	Pedestal and Bearing Assembly.
104	Oil Pipe Assembly.
105	Lining-out Bearings.
	&c.

Considerable help and guidance in fixing about a dozen such numbers for the chief and longest general assembly operations was obtained from the fact that set piecework prices were in vogue for them. Their beginning and end were thus clearly defined.

The minor operations, not included under these headings, many of which were performed by day-workers, were entered under number 100, meaning "general assembly." It sometimes happened that these minor operations, taking, as a general rule, half an hour or less, entailed special difficulties and occupied the fitter for three or four hours. When such was the case the fitters were instructed to write out by way of explanation a special time sheet for such work, under the general assembly number 100, but to give full particulars in the "description of work" column, instead of merely writing "general assembly," as they were told to do in respect of a series of short jobs. Such jobs as chipping away extra metal from a flange or flange cover, where they did not coincide neatly, came under this category and were described in the time sheet as :—

Drawing No.	Description.	Hours.
100	Chip and File Flange ..	4

If it were found that the cost of general assembly on a certain order had worked out at a higher total than usual, an examination of the time sheets bearing the figure 100 in the drawing number column would show at once the special features which had been the cause of the extra cost, leading to the possibility of steps being taken to prevent a recurrence. Sometimes it was found that these causes of extra work were really rectification, owing to defective machining or to a defective casting.

Many more examples of errors in time booking could be given, but they would be somewhat peculiar to the work of the particular factory under review. The more general classes of mistakes that have been discussed will, it is hoped, be sufficient to make cost accountants and others responsible for factory costing alive to the dangers of allowing men in the shops to exercise their imagination too freely in writing out time sheets. They must be given some guidance, and that guidance can only come from one who not only knows the uses to which the time sheets are put but who is also sufficiently familiar with shop practice to be sympathetic with the quandaries in which workmen sometimes find themselves, with regard to time booking.

The few simple remedies which the cost consultant was able to put into practice were far-reaching in their effect. They showed the men in the shops that some use was made of their time sheets and that the cost clerks wanted to be able to place reliance in what they read.

The greatly increased accuracy that was obtained in the time sheets made them of real use in getting down to the root of the troubles that were causing high costs. The help given by the drawing-office in listing operations on the labels accompanying the parts acted as a stimulus to the draughtsman to remember the machining operations required to turn his drawing into iron and steel, though the work did not occupy more than a minute proportion of his time in clerical labour. It made him appreciate that the work of his department was a link in the chain of production, which could only carry its full load when stretched taut in line with the other sections of the factory.

The changes went far, in fact, to pull into synchronism the various functions of the works organisation and to make them co-operate one with another.

One Hundred Years of British Railways.

No. XXIII.*

PART III.—THE LATTER HALF CENTURY.

THE YEARS 1876–1885.

1876.—The outstanding feature of the year 1876 was a series of serious railway accidents. On January 21st, as a consequence of a heavy fall of snow, the signals at two boxes north of Abbots Ripton on the Great Northern failed to go from "clear" to "danger" after the passage of a coal train, and whilst that train was being shunted into the up refuge siding to allow for the passage of the up Scotch express it was run into by the latter. There were no fatalities as a result of that collision, but before the express for Leeds could be stopped it ran into the vehicles of the Scotch train that had fouled the down line and

* No. XXII. appeared November 28th.

thereby thirteen passengers were killed. On July 27th the up Flying Dutchman was derailed at Long Ashton near Bourton, on the Bristol and Exeter section of the Great Western. The two enginemen were killed, but there were no serious injuries to the passengers. Two points should be noted:—(1) The line was converted from the broad to the mixed gauge in 1875, and whilst the longitudinal principle was continued the extra rail brought difficulties, and the permanent way inspector did not get all the increased staff he asked for; (2) the Bristol and Exeter had been taken over by the Great Western as from the previous April, and the permanent way inspector just mentioned told the Board of Trade Inspector "They had run too close with the materials towards the end of the Bristol and Exeter time, and it was about six weeks after the line was handed over before they could get material. . . . He could have kept the line better if he had had more men and material." The engine was No. 2001 of the well-known 4–2–4 tank type, the single driving wheels being of 8ft. 10in. diameter with a tire 6in. wide and no flange and carrying 18 tons 10 cwt. Captain Tyler, reporting to the Board of Trade, said that the engine was, in some respects, well designed for safe and steady running, and it would be very unlikely to leave the rails on a good permanent way maintained in high condition. The weight on the driving wheels was excessive, being more than the permanent way or works designed to support, and the absence of flanges on the driving wheels was a serious disadvantage when once the wheels of the leading bogie truck left the rails. His conclusions were that the permanent way was not in good condition. The off rail rested loosely on the longitudinal timber and the sleeper loosely on the ballast. The line was not in good level and the gauge was slightly tight.

Irregular working of single lines led to the collision at Foxcote, near Radstock, Somerset and Dorset Railway, on August 7th, whereby twelve passengers and one servant were killed. The block system was in operation and train movements were regulated by a timetable, the latter being subject to variation by a crossing agent at headquarters. That officer was unaware that one of the trains was running late and the timetable had to be varied locally without his knowledge. Moreover, one of the trains was dispatched without the necessary block signals having been exchanged. Severe criticisms were passed on the management of the line, but it was a case of locking the stable door after the horse had been stolen, as the Somerset and Dorset was just then being transferred to the Midland and London and South-Western companies jointly. On December 21st occurred another serious collision on the Great Northern. A goods train was shunting at Arlesey when three wagons were derailed and fouled the down line. At that period the line, under the block system, was normally clear except when a train was in the section. There was, furthermore, no "blocking-back" and, therefore, no means, except the fixed signals, to prevent the approach of the express for Manchester. The home signal was 283 yards from the wagons and the distant 898 yards, and as the gradient was a falling one of 1 in 440 the warning was very brief. The driver was heard to whistle at the distant but he failed to pull up in time, and in the consequent collision four passengers were killed. The driver and fireman jumped from the engine, but also met with their deaths. Captain Tyler's report observed that "whilst there was a want of caution on the part of the driver, the collision must be considered to be due in a much greater degree to the absence of adequate rules for carrying out the true principles of block working and to the want of more efficient brake power throughout the express trains." The Abbots Ripton and Arlesey accidents cost the Great Northern £100,000.

As the report of the Royal Commission of 1874 on Railway Accidents, which was to contain the results of the Newark brake trials of August, 1875, did not make its appearance, Mr. Dugald Drummond, who had the previous year left his post as assistant locomotive superintendent on the London, Brighton and South Coast to become locomotive superintendent to the North British, organised on behalf of the Scottish companies the brake trials which took place on December 22nd.

The new openings of the year 1876 included the East London Railway on April 10th. That work cost £3,200,000. The Settle and Carlisle of the Midland, having been in use for goods traffic since the previous August 2nd, was opened for passenger service on May 1st. The half-yearly report for June 30th, 1876, put its cost at £3,500,000, or £49,000 per mile. On June 1st the London and South-Western entered Plymouth. At Lidford it joined the line of the South Devon Company, which laid a third rail to its broad-gauge lines so far as Mutley, whence the South-Western had an independent line into Devonport. The London and South-Western and London, Brighton and South Coast joint line at Portsmouth Town was extended to Portsmouth Harbour on October 2nd.

In Parliament, as a result of the judgment given in an action taken by the North London Railway, a Select Committee was appointed to inquire into railway passenger duty. The Committee reported in June, but it was not until 1883 that any relief was given to the companies. Sanction was obtained for the absorption of the Bristol and Exeter by the Great Western, of the Sirhowy by the London and North-Western, of the Waterford, New Ross and Wexford by the Dublin, Wicklow and Wexford, and for the lease of the Somerset and Dorset by the Midland and London and South-Western.

1877.—The long-expected report of the Royal Commission on Railway Accidents was published on February 9th, 1877. In many ways it was not a satisfactory document. Of the nine original members the Duke of Buckingham had gone to India and Mr. Ayrton neither signed nor submitted a minority report. Of the remaining seven only four signed the report without reservations. Mr. T. E. Harrison added a rider, Mr. W. Galt also had a rider which was as long as the report itself, and Earl de la Warr presented a minority report. As a matter of record the report was very valuable, and the views expressed were sound, but it was obvious that the members saw that to interfere with railway administration was to partake of responsibility. As THE ENGINEER of February 16th, 1877, observed, "it is tolerably evident that they (the Commissioners) think that little or nothing can be done." Let us add that not for another twelve years did any Government submit proposals for making any safety appliance compulsory.

In every other respect the year 1877 passed without any great event of note. Defective permanent way, as a result of a ten days' frost being followed by rain, caused the East Coast up night express to be derailed at Morpeth on March 25th, with the result that five passengers were killed. The only other serious accident was at Billing-road, near Northampton, on the London and North-Western Railway, on October 18th. In that case, owing to an irregularity when working all traffic over the down line, a passenger train was sent over the up line and met a ballast train working on that line, which was still obstructed. Three passengers were killed.

In addition to these two accidents there was a serious landslip on the South-Eastern between Dover and Folkestone Junction. A severe storm washed away the foot of the cliff at the southern end of the Martello Tower and 60,000 cubic yards of chalk fell. Three men were killed and the line was totally closed from January 12th to March 12th, when a single line was opened. The summits of some of the other higher cliffs were blown up and reduced so as to prevent further falls. Double-line working was resumed on May 30th.

The only railway of importance opened during the year was that from Girvan to Challock Junction, on the Portpatrick and Castle Douglas line. It was 30¼ miles in length and was brought into use on October 5th. The opening out of the tunnels in red sandstone between Edge Hill and Lime-street, Liverpool, and the provision of additional lines and platforms was completed on April 9th; a third rail for narrow-gauge trains was continued from Taunton to Exeter on the Great Western and opened on May 24th; the present station at York was brought into use on June 25th; and the additional tunnel under Primrose Hill on the 30th of the same month; a temporary station in Manchester for the Cheshire Lines was opened on July 9th. The Great Northern of Ireland was established by an amalgamation of the Dublin and Drogheda, Dublin and Belfast, Irish North-Western and the Ulster.

1878.—This year was also fairly uneventful. Probably the event of greatest note was the opening, on June 1st, of the ill-fated Tay Bridge. Designed by Bouch, it was 3465 yards long, was carried on eighty-five piers, with spans varying in width from 29ft. to 245ft., and accommodated a single line of rails. On January 28th the Great Northern invasion of the Derbyshire coalfields was complete. Pinxton had been reached on August 1st, 1876, and on January 28th, 1878, a junction was made with the North Staffordshire at Eggington, and thus Burton-on-Trent was accessible for goods traffic and on April 1st for passengers. The crossing of the Great Western main lines on the level, outside Paddington, by the Hammersmith and City ceased in May, when the latter railway passed under the former by what was called a subway. The gradient at each end was 1 in 60. The London and North-Western and Great Northern joint lines between Market Harborough, Nottingham and Newark were opened on July 1st. The new south side of Waterloo Station was brought into service during the second half of the year and the additional two lines of way between Paddington and Slough were completed.

Five passengers were killed at Sittingbourne on August 31st in a collision between a passenger train and a shunting goods train, owing to the absence of interlocking; three were killed at Ballincollig on September 8th in a derailment and thirteen at Pontypridd on October 19th as a consequence of a signalman causing a passenger train to set back towards another box when another train was approaching the latter. In the Ballincollig case the directors of the Cork and Macroom Railway had to meet a charge of manslaughter for having allowed the line to fall into a bad state of repairs.

The Railway Returns (Continuous Brakes) Act—41 & 42 Vic., c. 20—of that year ordered the companies to submit half-yearly reports as to continuous brakes. They had to show the number of engines and carriages fitted and not fitted, and the number fitted during the half-year. The failures of the brake to act when a collision was imminent and in ordinary work were also to be reported. Powers were obtained for the South Devon Railway to be absorbed by the Great Western.

1879.—The railway companies about this time were passing through a period of financial depression and many of them made reductions in the pay of their servants. The Midland, for instance, reduced, in December, 1878, the wages of most of its staff by one shilling per week. Except by the signalmen, these reductions were accepted by the men, and the former subsequently fell into line under a re-classification scheme which created a higher grade of signal-box. The goods guards were paid by the trip, instead of by time, based on a sixty hours' week. In this the practice of the London and North-Western was followed. When the Midland increased the basis to a sixty-six hours' week the men struck work for the abolition of the trip system, and this strike was the principal opening event of the year 1879.

On June 2nd the Lancashire and Yorkshire Railway extended its Blackburn-Chatburn line to Hellifield, where it joined the Midland and allowed for a through service later by Midland trains between Scotland and Manchester and Liverpool. The Midland and North-Eastern joint line between Wath-road Junction and Knottingley was opened on July 1st; Glasgow Central Station on August 1st; the Nottingham and Melton of the Midland on October 1st; and the same company's Manton and Kettering on December 1st; the last spike of the Severn Bridge was driven on October 17th; and the Metropolitan, having been extended from Finchley-road to West Hampstead on June 30th, reached Willesden Green on November 24th.

The completion of the Inner Circle by the Metropolitan and Metropolitan District was sanctioned during the year, as was the establishment of the Great Northern and Great Eastern Joint Committee to administer the lines in Lincolnshire and Yorkshire that were to be taken over or built by those two companies jointly.

On August 17th the Llandulas Viaduct on the Chester and Holyhead line was washed away by a species of avalanche and thrown into the sea. A temporary wooden bridge was ready by the 24th, and within the same period girders for a new bridge had been made at Crewe. They were erected, and goods trains were running over the new permanent bridge on September 15th. A considerably worse disaster, however, occurred just as the year was ending. After going through the year with the excellent record of only three passengers killed in train accidents, the Tay Bridge was blown down on the night of December 28th, carrying with it a train containing seventy-three passengers, all of whom, together with the driver, fireman and guard, were drowned.

It was during the year 1879 that Edward Tyer introduced his tablet system and at once made the working of single lines safe, and the repetition of such accidents as the Norwich of September 10th, 1874, and Radstock of August 7th, 1876, impossible.

1880.—Some important works were brought into use during 1880. Holyhead inner harbour—described in THE ENGINEER of June 23rd and 30th—was opened by the Prince of Wales on June 17th, and the permanent Manchester Central Station, the roof of which had been illustrated in THE ENGINEER of February 20th and 27th and March 5th, was brought into service on July 1st, on which date also the Oban line was completed. The present station at Preston and the widening from Euxton was finished during the summer. On June 1st the Midland opened a fine fast service of trains between London, Leeds and Bradford.

There were five bad accidents that year. On January 15th a passenger train was started from Burscough Junction before the signalman had opened the points. It ran, therefore, on the facing road and met, head on, another passenger train. Five passengers were killed. The accident cost the Lancashire and Yorkshire £20,000. Insufficient super-elevation caused a derailment at Wennington on August 12th, when eight passengers lost their lives. An overlooked goods train which had been shunted on to the facing line led to three passengers being killed at Penilee on September 8th, and three days later five passengers were killed at Locomotive Junction, Nine Elms, through a light engine being forgotten. On December 21st, at Leeds, Wellington, a departing passenger train was allowed, as a consequence of hand signalling, to leave on the arrival road. It met another passenger train and three passengers were killed.

Powers for the construction of the Hull and Barnsley Railway were given during the year and for the absorption of the Monmouthshire by the Great Western, the Dingwall and Skye by the Highland, and the Port Carlisle and the Silloth by the North British.

1881.—The only openings of note during the year 1881 was that of the Mersey Railway on October 29th and the London and North-Western line from Rugby to Northampton on December 1st. The "gridiron" at Edge Hill, designed by Mr. Harry Footner, and the forerunner of gravitational shunting, was brought into use on March 21st.

What was apparently a minor matter but which led to a revolution was the appointment, on February 15th, of a Select Committee to inquire into the charges of railway companies, the laws and other conditions affecting them and the working of the Railway Commission of 1873. The Committee was re-appointed

in 1882 and, as noted below, reported on August 2nd of that year.

The only legislation, public or local, of note affecting railways was the Act for a new bridge over the Tay—the present Tay Bridge. A Select Committee inquired, during 1880, into the question of replacing the structure that failed in December, 1879, and reported that the bridge should, in the interests of the public and the railway company, be reconstructed, but that it should be 77ft. instead of 88ft. above high water. It was also recommended that the North British Railway should obtain approval of its plans by two or three independent engineers of unquestionable standing and experience. The plans of the present bridge were, therefore, prepared by W. H. Barlow, and Arrols were the contractors.

The failure of the Westinghouse brake on a Lancashire and Yorkshire train at Blackburn on August 8th caused a collision in which seven passengers were killed; the absence of a signal—the result of the great gale of October 14th—led to the signalman at Desford failing to notice that some facing points were set for the loop, and as a result a passenger train ran into a standing coal train and four passengers lost their lives; the disorganisation arising out of the failure of the Tay Bridge and the consequent necessity to restore the ferry from Tayport to Broughty Ferry led to a collision at the former place on November 25th, where five passengers were killed. The historical accident at Canonbury occurred on December 10th. In that case the Great Northern signalman at Finsbury Park accepted the bell "danger" signals sent by the North London signalman at Canonbury as indicating "clear" and three following passenger trains collided in a tunnel. Four passengers were killed.

1882.—The principal openings of 1882 were:—The line from Roade to Northampton on April 3rd, which put the latter on the London and North-Western main line; the Didcot and Newbury on April 13th; the Seamer-Pickering on May 1st; the Great Northern and Great Eastern from Spalding to Ruskington on March 6th, to Lincoln on August 1st, and throughout to Doncaster on September 1st. Two portions of the West Lancashire were brought into use in 1881 and the line was completed on September 4th, 1882.

On August 2nd the Select Committee on Railway Rates and Charges reported. It dealt with alleged preferential rates, a uniform classification, the justification for terminal charges and the strengthening of the Railway Commission. As the period is not covered by the present article it may be observed that not until 1888 was any legislation hereon passed. The only railway Act to be mentioned was the Post Office (Parcels) Act—45 & 46 Vic., c. 74—which gave the companies 55 per cent. of the parcels post receipts for their carriage.

There were three fatal accidents to passenger trains in 1882. On January 25th a sudden fog led to a collision at Hornsey, in which three passengers were killed. The breakage of a draw-bar derailed a wagon at Old Ford, North London Railway, on January 28th and threw it foul of an adjoining line on which a passenger train was approaching. Five passengers lost their lives. A concealed flaw, which could not have been detected, allowed a cast iron girder to fail under a train at Inverythan, Great North of Scotland, on November 27th, when five passengers were killed.

1883.—An event in 1883 of no little importance, in that it heralded the coming of electrical-operated railways in this country, was the opening, on January 18th, of the Giant's Causeway Railway, designed by W. A. Traill.

There were only two serious accidents that year. On March 19th at Eglinton-street, Caledonian, two converging trains met at a junction, owing to one of them over-running its signals. Four passengers lost their lives. On May 14th five were killed at Lockerbie, on the same system, as a result of bad methods of working leading to a signal which habitually was passed at "danger" being treated as a "clear" signal when actually it called upon the driver to stop.

A very important piece of legislation was the Cheap Trains Acts, 46 & 47 Vic., c. 34, which was the sequel to the work of the Select Committee, mentioned above, appointed on March 7th, 1876, to inquire into the railway passenger duty. It abolished the duty on fares of one penny per mile or less conditionally on the companies carrying workmen at reduced rates.

1884.—The new lines opened in 1884 included the following:—On March 10th the Croydon, Oxted and East Grinstead, which gave the Brighton Company an alternative route to that *vid* Redhill and Three Bridges. From Croydon to Oxted was jointly owned with the South-Eastern. On July 1st the South-Eastern line from Maidstone to Ashford; on September 1st the Southport and Cheshire Lines extension from Aintree to Southport; and on October 1st the Metropolitan and Metropolitan District connection from Whitechapel, St. Mary's, to the East London. The Belsize second tunnel on the Midland was brought into use on February 3rd, and the enlarged Victoria Station, Manchester, including what were then platforms Nos. 10, 11, 12, 13, 14, and 15, on May 1st.

Only two serious accidents occurred during that year, but in one twenty-four passengers lost their lives. That was at Bullhouse Colliery Siding, near Penistone, on July 16th, when the crank axle of an engine broke through a flaw which could not have been detected. Weak permanent way caused a derailment, killing five passengers, at Downton, on the 3rd of the previous month.

Mr. Chamberlain introduced a Bill to meet the recommendations of the Committee on Railway Charges, but it did not go far enough to please the traders and went too far for the companies. It was withdrawn.

1885.—The Railway Acts of the year 1885 included one for the purchase of the Belfast Central Railway by the Great Northern of Ireland Railway, and one for the acquisition as from August 1st by the London and North-Western, Midland, Caledonian, and Glasgow and South-Western of the Portpatrick Railway and of the Wigtownshire Railway, and for the establishment of the Portpatrick and Wigtownshire Joint Railway.

Several new lines and important extensions of existing lines were opened in 1885. They included:—Surbiton-Guildford and Leatherhead-Horsley on February 2nd; Barking-Upminster, May 1st; Newbury-Winchester, May 4th; Wareham-Swanage, May 20th; Paisley Canal line, July 1st; Scarborough-Whitby, July 16th; the Hull and Barnsley—described in The Engineer of July 24th—on July 20th; and Farranfore-Baltinglass in three sections during the year. The New-street Station, Birmingham, enlargement was completed on February 9th, and it became the then largest station in this country. The Birmingham West Suburban Railway of the Midland was doubled and extended in a northerly direction so that the company's trains to and from the West ran through Birmingham.

On and from July 1st, 1885, the Limited Mail no longer conveyed mails and other postal matter. The Postal Train was established, which left, and still leaves, Euston at 8.30 p.m. It carries Post Office matter and postal officials only, except that on Sunday nights it takes a sleeping car and an ordinary carriage for Stranraer.

Only one serious accident happened that year, and that was on January 1st. The axle of a privately owned wagon broke and caused the up line at Penistone to be fouled and a passenger train thereon to be derailed. Four passengers were killed. A sequel to that accident was the Railway Clearing House specification for privately owned wagons.

The Magnus Effect.

It may interest some of our readers to learn how the Magnus effect may be shown in very simple ways. The following demonstrations have been devised by members of our staff, but modifications will no doubt occur to our readers. (1) Make a tube—Fig. 1—of stiffish paper

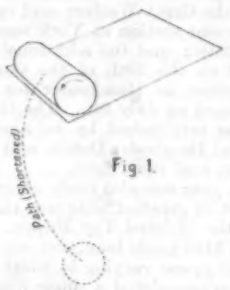


Fig. 1.

by gumming the edges together. Let its diameter be 4in. or 5in. and its length 1ft. to 18in. Place it on a flat piece of cardboard held some 5ft. or 6ft. above the floor. Tip the cardboard so that the paper tube rolls steadily down it and falls over the edge. It will be observed that the tube does not fall vertically, but takes a distinct inclination inwards—that is to say, in the opposite direction to any motion of translation imparted to it when rolling down the board. In this case the wind is represented by the resistance of the air to the falling tube, and the tube, viewed from the near end, has an anti-clockwise rotation; hence the deviation should be to the right, as, in fact, it is, the pressure on the left side of the tube being greater because the resultant speed of the "wind" and the circumferential speed of the air vortex round the tube is lower than on the right side.

(2) Stretch tightly between the picture rails of a fairly high room a cord. At the centre attach a vertical cord, and to that cord fasten by its vertical axis a fairly long and not too light cardboard cylinder, so that it is a few inches clear of the ground; by rotating the cylinder, the cord can be wound up and by its unwinding will start the cylinder rotating—see Fig. 2. At two other points on the horizontal cord equidistant by a couple of yards from the centre, attach two other cords and bring their ends together in a vee at a small ring just above the cardboard cylinder. The arrangement forms a pendulum, rigid in one direction but quite free to swing in the other. Now place an ordinary electric fan in such a position that it can blow on the side of the cylinder and place some large books in position to form a sort of grid to remove any rotation from the air current. Set the cylinder revolving, not too fast, and when it hangs vertically, switch in the fan. The deflection of the pendulum to right or left, according to the direction of rotation, is quite obvious. The best results were obtained with an ordinary cardboard roll, 20in. long by 3in. in diameter.

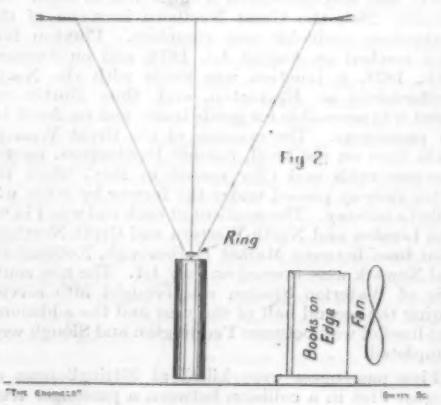


Fig. 2.

SIXTY YEARS AGO.

What must surely be one of the most remarkable railway catastrophes on record was reported in our issue of December 2nd, 1864. It had occurred on the Chicago, Burlington and Quincy Railroad. At one o'clock in the morning a locomotive, for some unknown and unfathomable reason, was standing by itself on a portion of the track which was perfectly straight and level for miles. At the same moment of time, two trains, one from the east and one from the west, approached and dashed into the stationary engine. All three locomotives and several of the cars were smashed and twelve or fifteen people lost their lives. . . . The Dictator, a great ocean ironclad ram, designed by the Swedish engineer Ericsson, was, according to a New York message, given in the same issue, a complete and most miserable failure. Instead of astonishing the world at large, she was then lying at the Brooklyn Navy Yard with her deck only 13in. out of the water, in spite of the fact that she had yet to take on board over 500 tons of stores, coal, &c. This weight, it was said, would be sufficient to sink the deck level with the water. This lack of reserve buoyancy was not her only fault. Her engines, it was stated, were not properly balanced, and turned round with the greatest difficulty, making a loud noise and giving an unpleasant jump. The anchor purchase, another of Ericsson's inventions, was powerless to raise the anchor. In short, the vessel, so it was reported, was "the greatest abortion of the age." . . . Elsewhere we recorded that a society had been formed in France to investigate and discover vegetable fibres for use in place of rags in the paper-making industry. Esparto grass, of which about 40,000 tons had been exported from abroad during 1863, had, it was stated, been found growing along the coast of Cumberland. Local paper makers were carting it to their mills in great quantities at the merely nominal price of carriage instead of having to pay five guineas per ton for the Spanish material. . . . A description was given in the same issue of "Fairlie's Improvements in Locomotive Engines." This article was a summary of the patent specification in which Mr. Robert Francis Fairlie, of London, described the type of engine subsequently associated with his name, and extensively employed at one time in Egypt, Mexico, &c. The engine, as is well known, had a double boiler, with the fire-box at the centre and was carried on two four-wheel bogies. The cylinders were mounted on the bogies, and were supplied with steam through pipes provided with ball and socket joints, which accommodated the motion between the boiler and the cylinders.

STANDARDISATION OF COLLIERY REQUISITES AND MATERIALS.

A meeting of the B.E.S.A. Sectional Committee on Colliery Requisites has recently been held in London under the chairmanship of Mr. Evan Williams, the president of the Mining Association of Great Britain, principally to report progress made since the inception of the work in June last.

Reports, together with detailed recommendations, were presented from the six regional committees which have now been fully constituted and held their first meeting. The Sectional Committee nominated the following gentlemen as permanent chairmen of the Regional Committees:—Birmingham, Mr. Norman Forrest; Cardiff, Mr. G. D. Budge; Glasgow, Mr. Mark Brand; Manchester, Mr. Jesse Wallwork; Newcastle, Colonel W. C. Blackett; Sheffield, Mr. H. Eustace Mitton.

A questionnaire for light rails, which is being drafted with the assistance and co-operation of the regional committees, is to be circulated to the mines in this country to enable the sectional committee to obtain particulars to assist it in dealing with this subject.

A report is being prepared in South Wales regarding the electrical apparatus which should be simplified and will be considered by each regional committee before the proposals contained therein are submitted to the sectional committee; in this connection the co-operation of the Association of Mining Electrical Engineers is expected to be most helpful

Realising the importance to the mining industry of the quality of the materials used, it has been decided to set up a national sub-committee, drawing its members principally from each of the regional committees, to consider this important subject and make recommendations as to materials for which specifications should be put in hand.

It has also been decided to set up a national sub-committee on steel arch girder supports as well as on black nuts, bolts and rivets. The question of the requirements of the mines for wire ropes was also considered, and it is understood that the fully representative B.E.S.A. committee already in existence under the chairmanship of Professor Henry Louis, is to give this matter early attention.

Reference was also made to the useful results obtained from the discussions of the address given by the secretary in the principal coalfields to which we have already made reference.

British Wire-drawing and Wire-working Machinery.

No. XVIII.—WIRE WEAVING LOOMS.*

The looms generally employed in the production of wire cloth, or gauze, closely resemble, in general principles, those used in the textile industries, but they possess, nevertheless, many distinctive characteristics, and these peculiarities are largely accounted for by the untractableness of wire as compared with fibrous yarns. Wire will not, for instance, yield so much as cotton or wool, and will break off short if over stressed, with the result that the cloth made is defaced by broken ends. Again, the specifications to which wire cloth is manufactured are often very stringent, and a single defect in a large area may result in the rejection of an otherwise valuable piece of material. Consequently all the working parts of a wire loom have to be made with the highest degree of accuracy. Wire, also, is not so flexible as yarn and the machines have to be run at a correspondingly reduced speed.

There is in this country quite a large number of firms engaged in the manufacture of wire cloth, and among them one of the largest is Richard Johnson, Clapham and Morris, Limited, of Newton Heath, Manchester. The works of this firm are also incidentally specially noteworthy through employing most of the principal types of wire loom, two of which are illustrated by the engravings Figs. 135 and 136. The first of these two classes is made by the Anderston Foundry Company, of Glasgow, while the second was manufactured by Walter McGee and Sons, of Paisley.

The new weaving sheds of Messrs. Johnson are illustrated by the engravings on page 642, and there is also an extensive separate department for the drawing of the wire consumed by the looms; but the procedure in the wire-drawing shops follows so closely the practice already described, that it is unnecessary to enlarge upon that part of the works. The output of wire cloth covers a very wide range both as regards the actual size of the pieces and the weight of the mesh, while a speciality has been made for a number of years in heavy rolled woven wire cloth in both copper and steel.

The stresses imposed upon the machine in weaving wire must obviously be much greater than they are with textile cloths, and the operation of "beating up" is one of the principal factors in determining the design of wire looms. "Beating up" is, of course, the action of forcing, by means of a "reed" and "lay batten"—described later—the weft or transverse wire up into the angle formed when the warp or longitudinal wires are separated for its reception, and it will be readily appreciated that in order to produce a fine mesh it is necesary to beat up hard, as the warp wires have to be bent back and forth round each of the wefts. Another difficulty is caused by the stiffness of the weft wire, which checks its unwinding as the shuttle goes from side to side of the cloth. Such considerations as these, together with the width of the material woven, determine the speed at which a loom can be worked, and the output ranges from about 120 picks a minute downwards, according to the gauge of the wire being used. A pick is, of course, the passage across the machine of a weft wire. In other words, a lineal inch of cloth of 120 mesh would be produced per minute when the machine was working at 120 picks per minute.

* No. XVII. appeared November 28th.

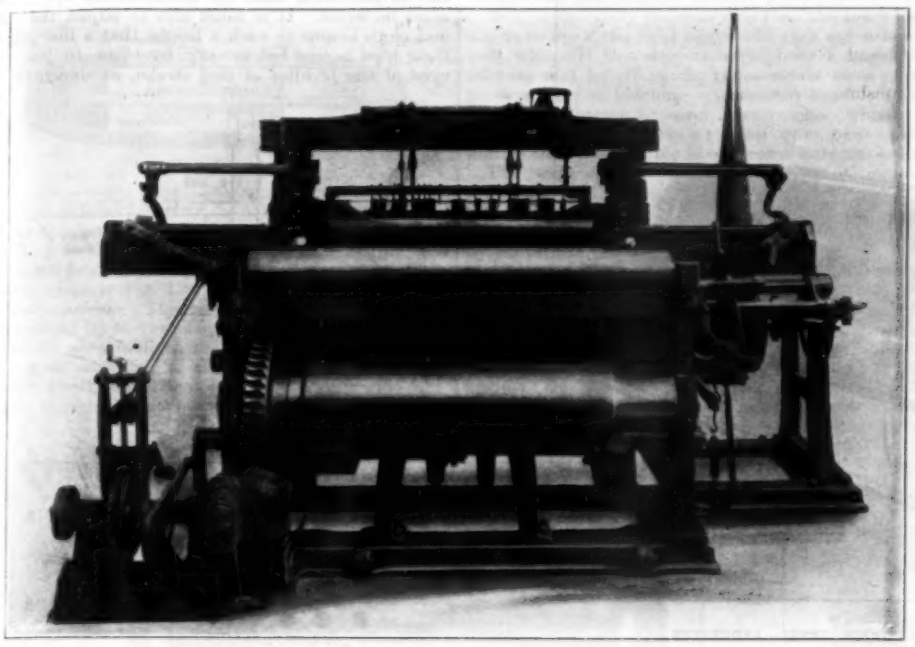


FIG. 135—FLYING-SHUTTLE WIRE-WEAVING LOOM—ANDERSTON

The mesh of the wire cloth produced is mainly governed by the structural strength of the loom and the gauge of the wire being used, which must be such as to allow of the necessary beating up to give the required mesh. Speaking generally, the heaviest make of cloth which can be woven from any given size of wire is one giving a screening area or opening of 25 per cent. That is to say, a cloth in which the meshes are arranged to leave square apertures equal in size to the diameter of the wire being woven. It is, however, possible to make a cloth even more dense than this by passing it through rolls, after it is woven, and thus squeezing out the wires to fill, more or less, the apertures.

Broadly speaking, wire cloths fall into three principal groups:—(1) Such as can be woven at a high speed, which limits the size of the wire to a maximum of about No. 25 S.W.G.; (2) cloths woven from heavier wires, which can be woven automatically, but at slower speeds, from wires with a maximum of No. 15 S.W.G.; (3) wire cloths and fabrics made from wires too stiff to be shuttled automatically, which involve the use of a semi-automatic machine, assisted by hand work. The consequence is that in any factory which sets out to manufacture the whole range of cloths, a variety of machines is required, and in the following notes an attempt is made to explain the leading features of the several types.

Taking first the loom illustrated by Fig. 135, by the Anderston Foundry Company, which perhaps follows more closely the practice of the textile industries than does any other one, the first characteristic which strikes one is the great care which is bestowed on the machining of the "warp beam"—the roll which is used to accommodate the supply of wire for the longitudinal part of the mesh to be woven.

It is obvious that the elasticity of the wires cannot be depended upon for taking up any inequalities in the rate at which the wire is supplied by the warp beam and, as a consequence, the warp wires have to be wound on to the beam in a meticulously even fashion. The warp beams are sometimes wound, or filled with new wire, in the looms themselves, but otherwise they are taken away to separate frames for winding. In either case the wire is fed into a series of deep grooves in the warp beam. Each of these grooves must contain an equal quantity of wire, or there may arise a difference in the tension of the individual wires at some time or another during the process of weaving a length of cloth. For this reason the warp beam is turned out of a solid cylinder of cast iron, and the grooves are machined with a very high degree of accuracy. The grooves are generally spaced at 1in. centres and consequently if, for instance, a cloth of 12 mesh is to be woven each of the grooves will have to accommodate twelve parallel wires. The result is that not only must the warp wires be wound very carefully but they must be matched one with the other.

Wire for weaving must be specially well annealed, and the annealing, as affecting the relative hardness, or softness, sometimes varies perceptibly in different parts of a coil. During weaving the wires stretch, more or less, and as hard wires will stretch less than softer wires, the effect of a few hard wires in a web will show throughout the whole length of cloth woven, and in closely woven cloths such hard wires may give so much trouble as to necessitate their being cut away from the warp beam.

For closely woven cloths it is also very necessary to check the wire for diameter, and it is not sufficient to accept a coil as being of the same gauge at both ends. If, for instance, of a cloth of 25 per cent. screening area were being made and the wire, starting at No. 25 gauge (0.02in. diameter), finished the coil at No. 24½ gauge (0.0216in. diameter), the cloth could not be woven towards the end of the run.

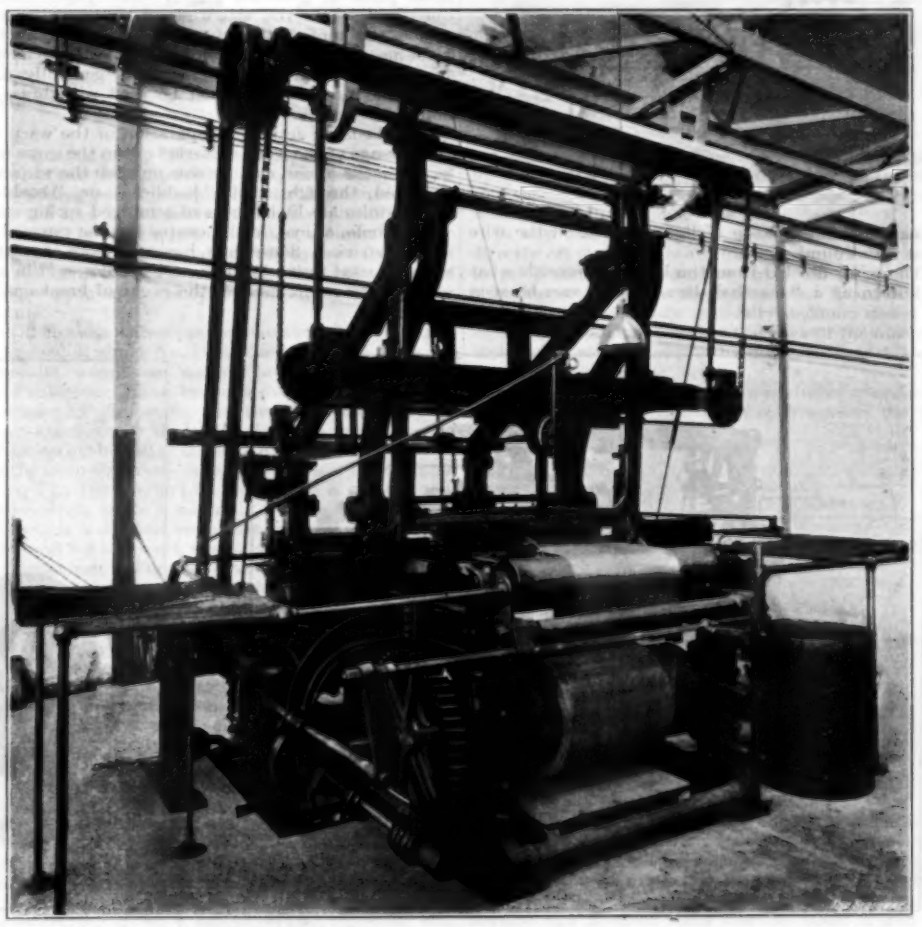


FIG. 136—POSITIVE-ACTION WIRE-WEAVING LOOM—McGEE

For this, and various other reasons, the warp wires are not wound directly on to the warp beam from the wire-drawer's coils; but are first wound on to bobbins and examined during the process. The bobbins are then put in a creel, as shown in Fig. 137,

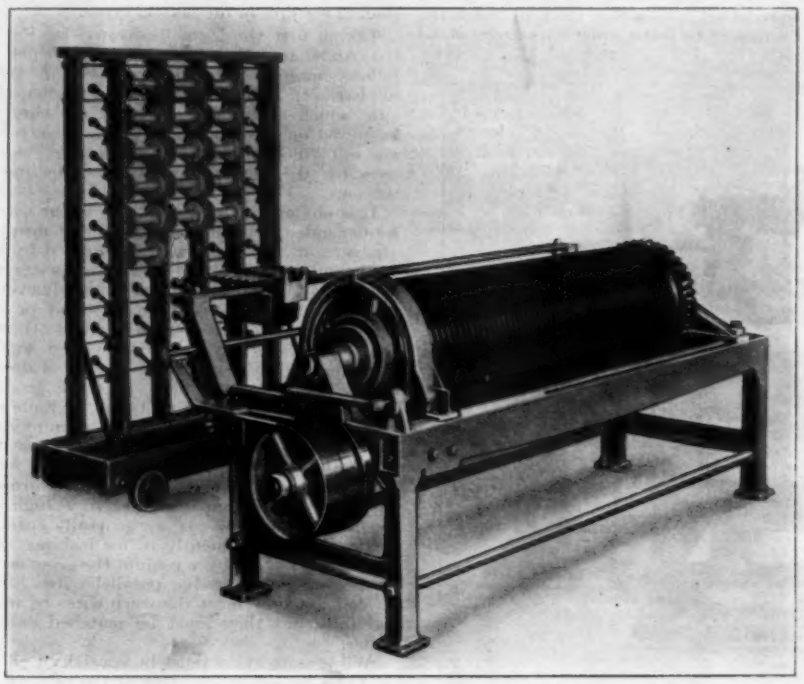


FIG. 137—WARP-BEAM WINDER AND BOBBIN CREEL—ANDERSTON

and taken to the separate beam winder, or to the loom, depending upon which system of winding is adopted. There is a little brake bearing on the flange

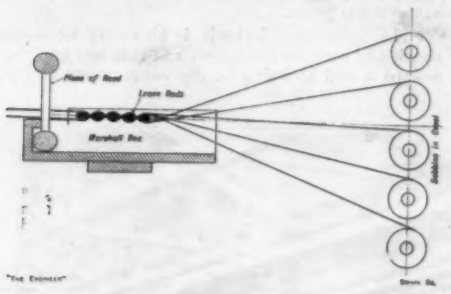


FIG. 138

of each bobbin to keep a slight tension on the wire as it is unwound.

The wires are led from the bobbins through what is known as a "marshall box," which can be seen fixed on a slide bar at the back of the winder in Fig. 137. The marshall box is fitted with five or six oval "lease rods" of hard wood—see Fig. 138—under and over which the wires are passed to produce an even tension. It is necessary that the wires coming from bobbins above the level of the box should start by passing under the first lease rod, and *vice versâ*, or the proper effect will not be obtained. After leaving the lease rods the wires are threaded through a short length of reed, which separates and keeps an even spacing between them. Finally, the attendant keeps a light touch, with his finger and thumb, on the ribbon of wires to guide them into the groove in the warp beam, to which each bunch of wires is first attached by looping it round a nail driven into a wooden peg sunk in the bottom of the groove.

If, in the process of winding, a loose or broken end of wire should appear, the attendant carefully twists the two ends together, and marks the place with a little piece of gummed paper. The paper subsequently attracts the attention of the weaver, who undoes the joint, so that the wire may go through the machine, and makes the joint again in the cloth. In weaving steel wire, the warp is generally first oiled, but no lubricant must be used with brass or copper.

The shedding action, or separation of the warp for the passage of the weft, is carried out in the same way as on textile looms, and for this purpose the wires are threaded through steel "heddles" or "healds." The heddles are little strips of tempered spring steel, with a hole, or eye, in the centre for the passage of each warp wire. Sometimes, however, loops of twisted wire are used instead of the steel heddles, and in any case a wire one is used in the event of breakage, so that the run of the machine is not interfered with.

The heddles are threaded on to round steel bars, and these bars are attached to two frames, each frame carrying the alternate transverse heddles. The frames are given a vertical movement by means of two "treading" levers operated by a two-leaved cam fixed on the bottom shaft of the loom, which is known as the picking shaft. In this way the warp is separated into layers, or sheds, between which the weft wire is shot by the shuttle.

The adjustment of the shed opening in a wire loom is a very important matter as wire cloth is very liable to show imperfections through bad adjustment in this direction. The heddles must, of course, be so set that the eyes are all in line and parallel with the face of the cloth, while the stroke of the two frames must be equal. It is usual also to adjust the warp and cloth beams to such a height that a line joining their tops is just below—say, by $\frac{1}{16}$in. to $\frac{1}{8}$in.—the eyes of the heddles at mid stroke, as shown in the

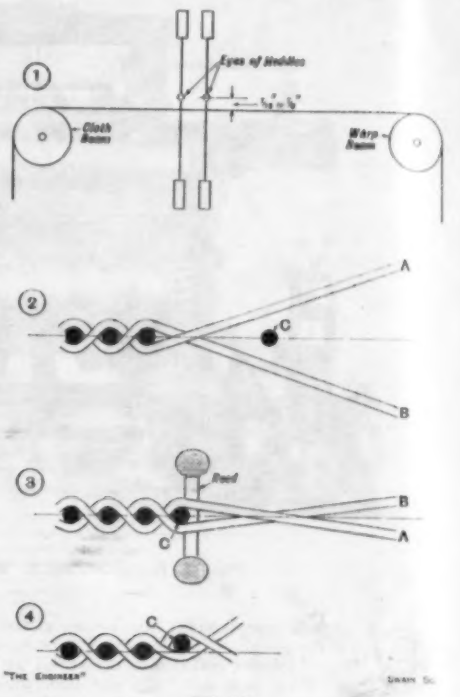


FIG. 141

upper sketch of Fig. 141. This setting is adopted for the following reason:—

If, at the time when the lay batten is back, the sheds are open and the shuttle leaves a weft wire C—see 2, Fig. 141—in the shed, the distances of A and B from the line between the beams are equal, the tensions in the two sets of weft wires must be equal. The next sketch—3—shows the reed on the point of beating up the weft after the sheds have crossed. If, however, there happen to be one or two slack warp wires, there will be a tendency for the weft to rise or fall as these wires yield—as indicated in sketch 4—and the indiscriminate deflection of the weft will result in unsightly patches in the cloth woven. By adopting the high setting of the heddles just mentioned, the lower shed is constantly the slacker, and there is a persistent tendency for the weft wire to appear on the top surface of the cloth.

The cloth beam, on which the woven cloth is wound at the front of the machine, is a heavy cast iron roll. A groove is cut along the roll and in this groove a bar

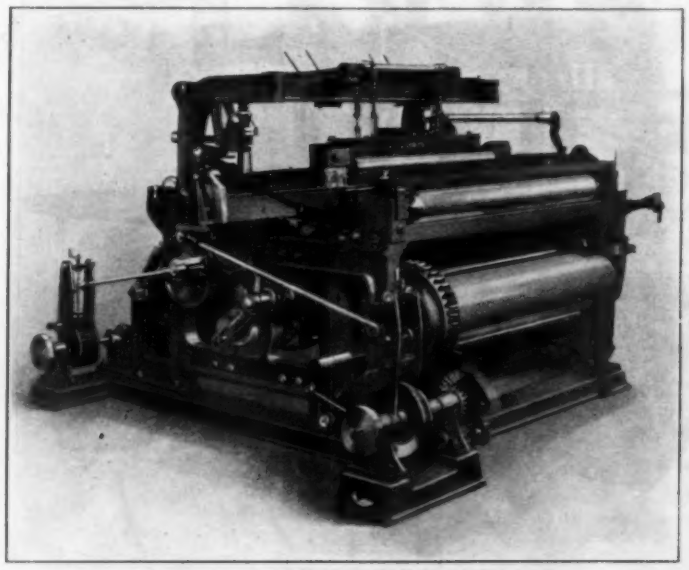


FIG. 139—HIGH-SPEED OVER-PICK LOOM—ANDERSTON

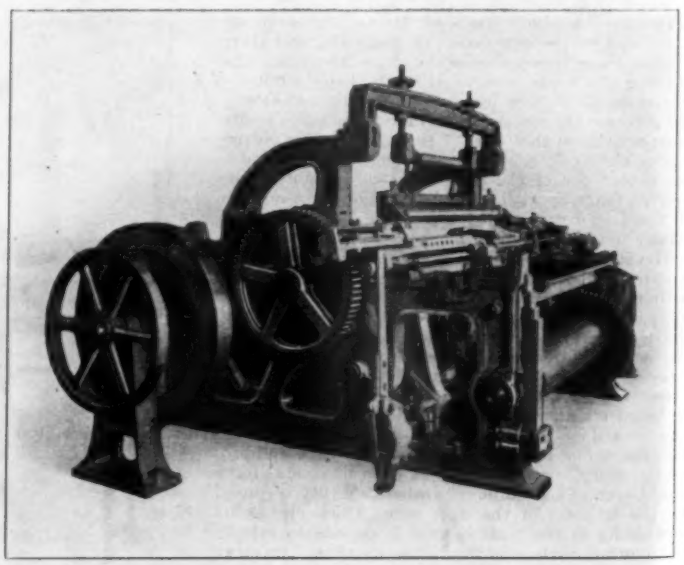


FIG. 140—HEAVY AUTOMATIC LOOM—ANDERSTON

is fixed by countersunk screws for the attachment of the warp wires when the weaving is started. In this connection, it is noteworthy that there must always be a certain length of unwoven wire, at both ends of the cloth, on account of the distance from the picking line, where the weft is shot across, to the two beams, and it is naturally the aim of manufacturers to reduce this waste wire to a minimum.

A variety of different schemes is employed for paying out the wires from the warp beam, as the weaving proceeds, and at the same time keeping the

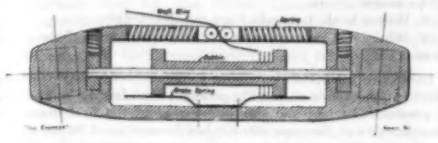


FIG. 142

proper tension on the warp, while the woven cloth is rolled up at the front. Part of the gear can be seen in the left foreground in Fig. 135, but a more complete view is given in Fig. 139, which is of a different and heavier machine. The movement of the warp beam is regulated by the ratchet seen at the rear, which is driven by a variable stroke crank. This crank is, of course, set according to the mesh to be woven. The ratchet wheel, it will be noticed, has a very wide face, and is engaged by several pawls, set a fraction of a pitch in advance of one another, so that a very regular movement is obtained.

As the weaving proceeds and the warp is consumed, the diameter of the roll is naturally reduced, and an adjustment has to be made or the mesh would vary. This adjustment is made by means of the sliding crosshead seen on the ratchet arm. The weaver has to count the meshes woven, say, every quarter of an hour, and make the necessary adjustment.

The taking-up gear on the cloth beam works on much the same principle, but a V groove is used instead of a ratchet. A refinement recently introduced

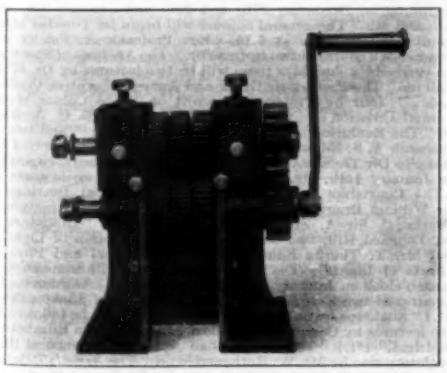


FIG. 145—CRIMPING MACHINE—ROBERTSON

by the Anderston Company is a connection between the let-off and the uptake gears to make the adjustments in the speed of the two beams simultaneously, so that there is no fear of the wires being broken by being drawn forward faster than they are let off. Another improvement is a mechanism, which, by bearing against the outside of the roll of cloth, controls the taking-up ratchet automatically.

The let-off and uptake movements are driven independently, and do not necessarily work in unison with one another; in fact, it is advisable that they should not do so, for the following reason:—

When the sheds begin to cross, the tension in the web naturally slackens, and the wire should be let off from the warp beam at that moment. The movement of letting off must, however, be completed before the reed strikes the edge of the cloth, in the action of beating up, so that the web may be rigid to resist the blow. On the other hand, the take up should be timed a trifle later, as the beat up tends to slacken the cloth in front of the reed, and that is when the cloth beam should take up. The actual delay between the let off and the take up is approximately half a stroke.

It is occasionally necessary to turn the loom backwards to open the shed again and pick out a broken weft wire. If this were done without releasing the take-up and let-off pawls, there would be a double mesh when the machine was started again. In the Anderston looms, however, the ratchet wheels are free to reverse for nearly a revolution without operating, so that this trouble is overcome automatically.

The weft wire is carried in different manners according to its gauge. Thus wires up to No. 25 S.W.G. are wound on tapered pirns, in the same manner as cotton, carried by a flying shuttle. The wire comes off the end of the pirn, which does not rotate. For heavier wires, up to, say, 20 gauge, this system is not practicable, and it becomes necessary to wind the wire on a bobbin or spool, which is carried in the shuttle and is free to rotate. In the Anderston loom the bobbin is arranged, as indicated in Fig. 142. It will be noticed that there is a light leaf spring bearing against the flanges which produces just enough braking action to stop the bobbin spinning at each end of its stroke. The wire is led off the shuttle between two little grooved wheels, which are mounted in a sliding carriage controlled by light springs, so that the wire is led fairly off the bobbin. The rolls on which the shuttle runs are set at a slight angle to make the back of the shuttle bear against the face of the reed as it is shot through the shed. The speed of a loom using such a shuttle is about sixty picks per minute.

Still heavier wires can be shuttled, but the limit is reached at about No. 15 S.W.G., and such wires are generally wound on narrow bobbins lying flat in steel shuttles. These bobbins may be about 5in. in diameter by 2in. wide, and the effort necessary to shoot them across the cloth, together with their retardation at the end of the stroke, are serious problems for the loom designer. As a consequence, the machine—see Fig. 140—cannot be worked at a speed much above thirty picks a minute.

There is a demand for cloths made of still heavier wire, and for this work a semi-automatic loom—such as that shown in Fig. 143—has to be employed. The weft wire is then passed through the shed of the warp by hand. The wire is wound on a needle, something like that used by a fisherman in netting, and this needle is pushed through at each stroke of the machine by the attendant.

Even stouter wire, up to ¼in. in diameter, is woven, but then it is cut off in lengths equal to the width of the cloth, and if a close mesh is required the wire is crimped before it is woven.

A small crimping machine by W. H. A. Robertson and Co., of Bedford, is shown in Fig. 145, and needs hardly any description. It consists of two spindles geared together mounted in a frame. The rolls are of hardened steel having teeth to conform with the crimp required. It is usual to fit three rolls with standard size pitches between the housings and leave a space on the outer ends of the spindles to carry special sets. The engraving shows a hand-operated machine, but a belt pulley can, of course, be fitted, if necessary.

Cloth made in the manner just described has not, of course, any selvedge, and the ends of the warp wires have to be twisted over by hand if a finished edge is required.

The production of a good selvedge to wire cloth always presents difficulties for several reasons. There is, for instance, the liability for the weft wire to kink, as the shuttle must over-run the width of the cloth, and consequently leaves a loose loop of wire as it starts on its return journey. When a pirn shuttle is being used, there is an added tendency for kinks to form as the wire is given a twist as it comes off the pirn. One of the most common ways of overcoming this difficulty is for the girl attending the loom to put her finger lightly on the wire as the shuttle emerges from the shed and hold it until the tension comes on again on the return pick of the shuttle. Her attitude in doing so can be plainly seen in the lower engraving on page 642. In the Anderston loom, however, there are two devices like the "tension" of a sewing machine. They can be seen in Fig. 135 near either end of the breast roller, and are cupped-shaped pieces pressed together lightly. The wire slips between the two and is held just sufficiently tightly to prevent kinking, but not so much as to check the shuttle.

Another difficulty in making a good selvedge is caused by the tendency for the outside warp wires to be dragged out of line by the pull of the weft. One method of overcoming this trouble is to arrange a pricker to come down next to the edge of the cloth at each pick—as roughly incidated in Fig. 146—for the weft wire to be looped round. The point has, of course, to be so geared with the mechanism that it is lifted out of the way at each pick. Another system is to feed a length of strong piano wire into the selvedge at the start of weaving and attach the back end to the frame of the machine as soon as the front end approaches the cloth beam. Then the weft wires

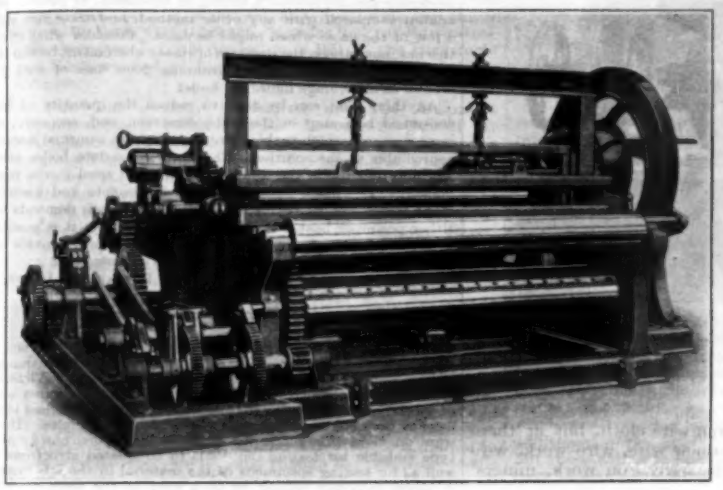


FIG. 143—HEAVY SEMI-AUTOMATIC LOOM—ANDERSTON

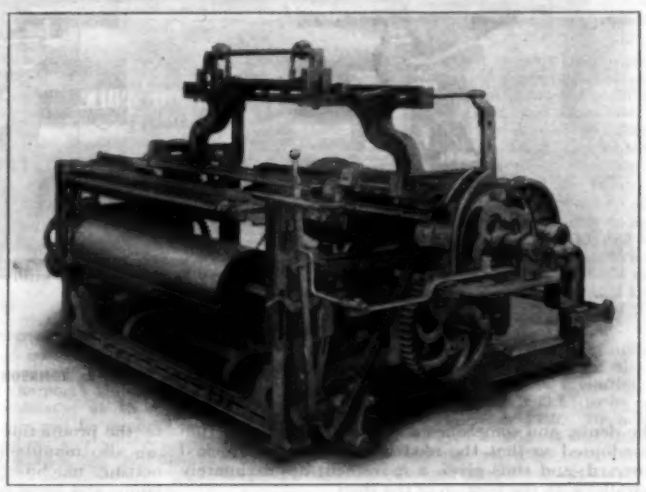


FIG. 144—WIRE-WEAVING LOOM—HATTERSLEY

are all turned over this piano wire, which is kept taut by the cloth being pulled forward and off at the end. In other words, the piano wire remains stationary while the cloth is pulled over it.

In any case the selvedge wires are seldom taken directly off the warp beam for they would then tend to get slack, as they are not subjected to the same crimping action as are the weft wires. The selvedge wires are consequently generally accommodated in separate bobbins mounted at the back of the machine and wound round pieces of buffalo hide to give them the necessary tension.

With heavy grade goods there is always a tendency for the selvedges to pile up on both sides of the roll

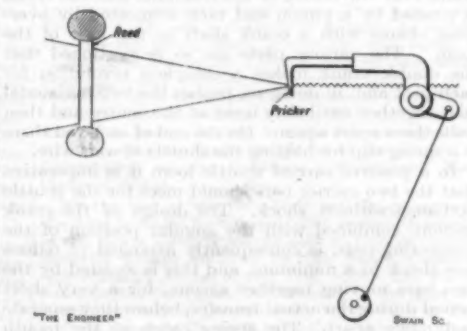


FIG. 146

of cloth, an effect which is more or less present even in much lighter fabrics. If the piling up of the selvedges on the roll of cloth, as it winds up on the cloth beam, were allowed to continue, the cloth when unwound from the loom would not lie flat. To obviate this ill-effect some weavers insert a web of calico between each layer of cloth as it winds up on the cloth beam. In the case of the machine shown in Fig. 139 the makers provide a selvedge flattening apparatus which beats down the selvedges on the cloth beam at every stroke of the loom, and the gear is so arranged that the same effect is given no matter to what diameter the roll of cloth may build up.

The reed used for beating up the weft wire into

the corner of the shed of the warp is an important part of a wire loom, as it has heavy work to do. It is built up of a number of thin steel plates, known as dents, a dent being arranged between each pair of adjacent warp wires. There are several methods of building up the reed, such as binding the dents together with twine, and soldering them, but neither seems to be a really mechanical job. The reed is carried by the lay batten and is rocked forward about a fulcrum in the base of the loom; after each weft wire has been shuttled through the shed opening the reed drives the wire firmly into place in the angle between the warp wires. It is obvious that the reed must be deep enough to allow for the separation of the warps to form the shed, and if the beat up took place at the centre of its depth, there would be a tendency for the dents to give under the blow. For this reason the position of the fulcrum is so chosen that the beat up is effected near the bottom end of the dents, and sometimes a special excentric fulcrum is adopted so that the reed is raised as it is rocked forward, and thus given a movement approximately parallel with the bottom of the shed.

In the case of the machine illustrated by Fig. 143 the lay batten slides on inclined slides provided on the loom side frames, the inclination of these slides being parallel with the inclination of the bottom shed of warp wires, thus ensuring that the blow from the reed when laying the weft wire up to mesh will be received right down at the root of the reed. It will also be noticed that the machine is provided with a very heavy fly-wheel, and the whole energy of this fly-wheel is available to do the work in knocking the weft wire up to mesh.

In the McGee loom—shown in Fig. 136—the method of working the shuttle is of the positive type and is quite peculiar. It will be observed that on either side of the machine there is a long carrier bar or shuttle arm working horizontally between pairs of rollers. These bars are connected with a double crank over the centre of the machine, and the crank is rotated by a pinion and rack connected by overhead chains with a crank shaft in the base of the loom. The various parts are so proportioned that the double crank makes a complete revolution for each pick and, in doing so, pushes the two horizontal rods together until they meet at the centre and then pulls them apart again. On the end of each rod there is a spring clip for holding the shuttle of weft wire.

In a positive carried shuttle loom it is imperative that the two carrier bars should meet for the shuttle exchange without shock. The design of the crank motion, combined with the angular position of the connecting-rods, is consequently arranged to reduce any shock to a minimum, and this is assisted by the two bars moving together as one, for a very short period during the actual transfer, before they separate and move apart. The spring catch at the mouth end of the carrier bar, which holds the shuttle, is operated by means of a rod passing through the centre of the bar and a catch gear on each side of the loom. In the transfer both carrier bars close on to the shuttle and the catch gear operates so as to release the spring of the bar which is to pass the shuttle over to the other bar, after which the bars recede, thus carrying the shuttle from side to side of the cloth. The arrangement has the advantage that heavier wires can be handled than is possible when the momentum of a shuttle is depended upon to carry the weft wire through the shed.

Another loom of a special type is shown in Fig. 147 and is known as a heavy bar loom. This loom is fully automatic with a positive shuttle action, but is designed without overhead gear, while the carrier bar drive is obtained by a special patented motion at each side of the loom. These machines are used for weaving heavy cloths such as rice cloth, and it is the intention of Messrs. Johnson to develop this special type of loom as the necessity of business demands.

The loom shown in Fig. 144 is by George Hattersley and Sons, of Keighley, and will work with wire up to No. 28 gauge at a speed of some 120 picks per minute and up to a mesh of 120 per inch. It is of the underpick type, and has a warp beam built up of cast iron distance pieces with mild steel discs keyed on to a shaft 3in. in diameter.

A wire weaving works naturally involves the provision of machines for filling the shuttle bobbins, but as they closely resemble those used in cable making they need not be described in detail here.

In passing, it should be mentioned that the works of Rd. Johnson, Clapham and Morris are not confined to the production of woven wire cloth, but at them are also manufactured copper wire, wire work, wire netting, machinery guards, light iron work, miners' lamps and brass castings.

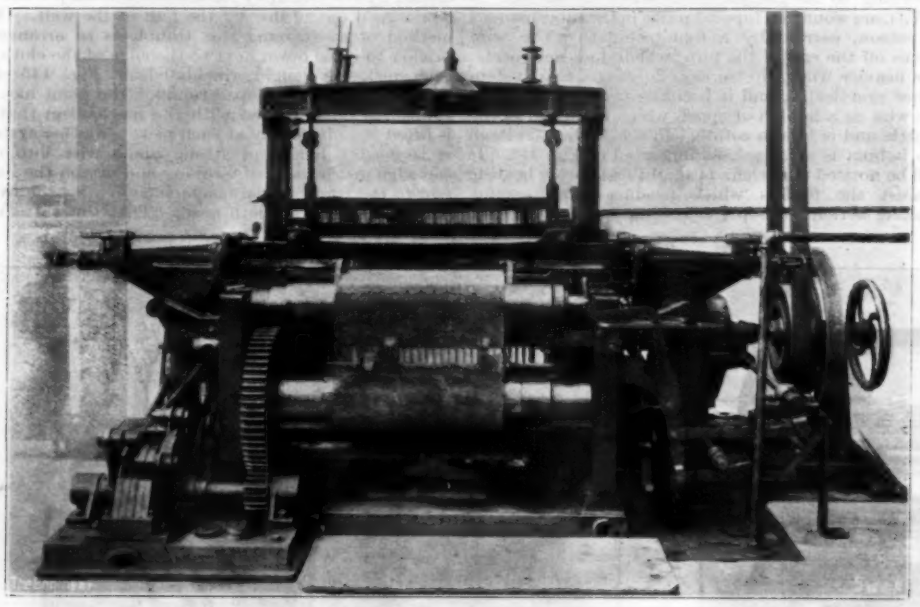


FIG. 147—HEAVY BAR LOOM—R. JOHNSON

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

POWER SUPPLY AND SMOKE ABATEMENT.

Sir,—When we consider how other countries which have no natural supply of fuel use steam, the wastefulness of our methods is very apparent. For some years now we have been rapidly approaching the conditions existing in other countries, owing to the increased price of fuel, but so far we have done very little to alter our methods of using steam to suit the new conditions. There is no marked reduction in our fuel consumption in relation to our output, with the result that the price of our products has risen with the price of fuel.

When coal was, comparatively speaking, cheap, say, one-third of to-day's price, the problem was different, and we could afford to use it in a different way with an abundance of cheap steam. Boiler efficiency has been much improved, so that the amount of steam raised in relation to the fuel consumed has increased; likewise, the amount of power generated in proportion to the steam consumed has improved, but this is not the extent of the problem or its solution.

Practically all manufacturers require heat in addition to power—generally in the form of steam. Heat or process steam is the weak link in the chain between the consumption of fuel and the generation of power in this group of factories. After doing so much to improve the thermal efficiency of our steam-raising plant, compare it with the thermal efficiency of our steam-using plant. Having burnt the fuel and obtained 90 per cent. of the heat, we deliberately throw away at least 60 per cent. of this heat in generating power, and to make up the deficiency we burn a further 40 per cent. of fuel. Our generating stations are designed to manufacture the maximum amount of power for the fuel they consume, and the heat which they generate in the process is sacrificed in obtaining this result.

The larger the units, the better the consumption, with the result that units have now reached such dimensions that it would not be possible to find sufficient space in their immediate neighbourhood for consumers who could absorb their heat.

Transmission comes into the problem. Our large generating stations are now built as far from cities as possible. This does something to reduce the smoke nuisance, but the distance is limited and 20 miles has been quoted by one leading authority as a maximum that electricity generated by burning coal can be commercially transmitted in competition with coal transported by rail; the limit for the transmission of heat is about one-twentieth of this distance, hence combined super-power and heat stations are impossible.

Now consider the problem with respect to our factories. In the first instance these are necessarily in populated districts on account of labour. If they require power only, as in spinning mills, for instance, they have two alternatives, either to buy electricity in bulk from an outside source or to install their own plant. For generating prices there does not seem to be much to choose between the two, so far as the cost is concerned, for a load of about 1000 horse-power. The problem of the factories, where heat and power are required, is quite another matter. Power can be purchased, but not heat, except in some exceptional circumstances. This class of factory may be divided into four groups, as follows:—

(1) Where the demand for a constant supply of low-pressure or process steam is equal to the steam required to produce this power.

(2) Where the demand for process steam is always in excess of the power steam.

(3) Where both demands vary independently.

(4) Where the power steam is always in excess of the process steam.

These are all instances where it undoubtedly pays to install plant in preference to buying power. Fuel has to be consumed to produce the heat, so should be used in the first instance to generate power, because after it has been so used 90 per cent. of its heat is still available for process requirements. The different conditions call for various types and combinations of plant, but this presents no difficulty to engineers who have given the problem many years' consideration.

A good deal has already been done on these lines, and the savings effected are so fully realised that it can only be a matter of time before all factories in the group are equipped with their own combined power and heating plants, and thus take the fullest advantage of a system which provides them with power at a nominal cost.

To quote actual cases of the savings effected where this system has already been adopted:—Amounts of coal varying from 1000 to 2700 tons per annum have been saved, boiler plant has been reduced by 40 per cent. and fuel cost of production by 25 per cent., enabling the capital expenditure on the plant to be written off over a period of 3½ years. This in a factory of moderate size represents a saving of thousands of pounds per annum compared with any other method, and these are only a few of the cases which might be cited. Consider what effect this has, not only on the question of smoke abatement, but on the balance sheet, with boilers consuming 2000 tons of coal per annum as an average figure per boiler.

Anything that can be done to reduce the quantity of fuel consumed is a step in the right direction, and, secondly, all improvements which enable plant to be used in a normal manner contributes to the solution. The most up-to-date boiler plant will only aggravate the difficulty if it is not used in the right manner. The usual cause of smoke is obsolete and wasteful plant which has to be forced to deal with peak demands for either power or heat. With a combined system, it is possible to select plant and run it in a manner which will provide for peak loads with a steady and normal fuel consumption.

December 1st. Eustace E. Baker.

Exhibition of Scientific Instruments and Apparatus.—An Exhibition of Scientific Instruments and Apparatus, arranged by the Junior Institution of Engineers, was held at 39, Victoria-street, on November 28th. All the instruments exhibited were of special interest, in that they embodied new and original ideas or that they contained improvements on old principles. There were on view different forms of stress indicators, chiefly of a type suitable for testing materials in completed structures as well as for testing specimens of the material in the laboratory. A stress indicator similar to that used in the tests recently conducted on Westminster Bridge was exhibited. Amongst a number of engine indicators was a Farnborough electric indicator for use on engines running at very high speeds. In it the pressure in the engine cylinder is opposed in a valve chamber by compressed air, a reading being recorded electrically when the pressure in the cylinder just balances the pressure of the air and causes a valve to move off one seat on to another. The air pressure does not vary rapidly and can therefore be ascertained. The record is made at the moment of equilibrium on a drum which moves in synchronism with the engine piston. Another interesting exhibit was an optical pyrometer which indicates the temperature of metals in a furnace by matching the colour of the hot metal with a glowing filament in a lamp. The brightness of the filament is regulated by a rheostat and is registered on the scale of a milliammeter, which is calibrated to show degrees of temperature. A mercury vapour lamp of the atmospheric type with a quarts body was also shown in operation.

Royal Institution.—The before-Easter lecture arrangements at the Royal Institution have just been issued. The subject of the Christmas course of lectures for juveniles is "Concerning the Habits of Insects," to be delivered by Mr. F. Balfour Browne, beginning on December 27th and 30th and January 1st, 3rd, 6th, and 8th. The general courses will begin on Tuesday afternoon, January 13th, at 5.15, when Professor A. Fowler will commence a course of two lectures on "The Analysis of Spectra." On succeeding Tuesdays there will be two lectures by Dr. H. R. Hall on "The Prehistoric Greek and Ancient Egyptian Civilisations;" four by Professor Barcroft on "The Colour of the Animal Creation;" two by Professor E. N. da C. Andrade on "The Evolution of the Scientific Instrument;" and two by Professor A. S. Eddington on "The Internal Constitution of the Stars." On Thursday afternoons at the same hour, beginning on January 15th, Mr. J. S. Huxley will give two lectures on "The Courtship of Animals and its Biological Bearings;" Sir William Bragg, four on "The Properties and Structure of Quartz;" Sir A. Smith Woodward, two on "Dinosaurs;" Dr. Leonard Hill, two on "The Biological Action of Light;" and Mr. T. Thorne Baker, two on "Chemical and Physical Effects of Light." The Saturday lectures will commence at three o clock on January 17th, when Professor G. Gordon begins a course of two lectures on (I.) "The Women of Shakespeare," (II.) "Shakespeare and the Spirit of Comedy," to be followed by two lectures by Canon E. H. Fellowes on (I.) "The Elizabethan Madrigal," (II.) "The Elizabethan Ayre," with musical illustrations; two by Mr. W. Rothenstein on "The Artist's Relation to Social and Religious Life;" four by Sir Ernest Rutherford on "Counting of the Atoms;" and two by Professor J. H. Ashworth on a zoological subject to be announced later. The Friday evening meetings begin on January 16th with a discourse by Sir William Bragg on "The Investigation of the Properties of Thin Films by Means of X-rays." Succeeding discourses will probably be given by Dr. A. W. Crossley, Professors J. W. Gregory, R. W. Chambers, T. H. Pear, Gilbert Murray, J. W. McBain, Principal Irvine, Mr. W. B. Hardy, Sir Ernest Rutherford, Sir Daniel Hall, and others. A general meeting of the members of the Royal Institution was held on Monday afternoon, December 1st, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The special thanks of the members were returned to Dr. H. Rushton Parker for his donation of £100 towards the improvement of the library. Professors Theodore Lyman, of Harvard University, and Gilbert N. Lewis, of the University of California, were elected honorary members, and Professor E. N. da C. Andrade, Mrs. M. H. Daniell, Dr. G. C. Simpson, Dr. D. P. Subotic, and Mr. W. J. U. Woolcock were elected members of the Institution.

Railway Matters.

ON Monday last, the 1st instant, the Great Western opened a station at Iver, between West Drayton and Langley. It has platforms on the local lines only.

THE railway companies have voluntarily expressed to the National Union of Railwaymen their willingness to have the proposed enginemen's mileage increase from 140 to 150 per day referred back to the National Wages Board.

IT is announced that the electrification of the Bombay harbour line by the Great Indian Peninsula Railway Company, which has now been completed, will come into practical operation early next year. The inaugural ceremoney will be formally performed by his Excellency the Governor of Bombay on February 2nd.

THE Southern Railway Company has deposited a Bill for the acquisition of the East London Railway. It may provide some interesting developments, as the London and North-Eastern—as successor to the Great Eastern—and the Metropolitan and Metropolitan District are fellow lessees with the Southern of the East London.

IN view of the railway centenary next year, the London and North-Eastern Railway Company is compiling a list of men still living who were employed on the old Stockton and Darlington Railway, the first in the world. An appeal is being made for names and addresses, which should be sent to "Railway Centenary," L.N.E.R., King's Cross Station, London.

THE Railway Bills deposited for next session include one by the London and North-Eastern for a line from Gedling, outside Nottingham, to its main line at Retford; for modified proposals as regards Scunthorpe, and for widening at Fenchurch-street. The London, Midland and Scottish proposes to build a line, 14¼ miles long, from Farnsfield, on the Mansfield and Southwell branch, to East Retford, with a branch, 2¾ miles long, at Edwinstow. The company is also depositing a Bill in the Parliament of Northern Ireland for the acquisition of the Ballycastle Railway.

THE Bill recently introduced into the Australian Commonwealth Parliament for the construction of the Kyogle–South Brisbane railway is the first step towards a standard gauge line between Brisbane and Perth, *viâ* Sydney, Hay and Port Augusta. The cost of the line between Kyogle and South Brisbane is estimated at £3,500,000, of which £1,000,000 would be expended in the construction of a bridge over the Grafton River. The other section from Hay to Port Augusta would cost £4,500,000, and there would still remain the construction of a standard gauge line in place of the 3ft. 6in. line from Kalgoorlie to Perth.

IN his message to the staff in the November issue of the *Great Western Railway Magazine*, Sir Felix Pole, the general manager of that company, points out that up to September 28th the company had carried 41,361,191 tons of coal, as compared with 44,147,765 tons in the corresponding nine months of 1923, and that there was a decrease of £348,000 in the mineral receipts. There was, further, a decrease of more than a quarter of a million in the merchandise receipts, and though the passenger traffic had brought in £74,000 more, the net receipts from all traffic showed a decrease of over half a million. There was also the fact that the wages bill was very much higher this year than last, the excess up to October 4th being approximately a million pounds.

THE first train over the reopened Moorgate-Clapham Common section of what is now to be known as the City Railway—and not the City and South London—was driven on Monday morning last by Miss Marion Stanley, the daughter of Lord Ashfield, the chairman. Approaching Clapham-road Station the brakes were suddenly applied. The shock was not sufficiently severe to have been caused by the train having been "tripped" by an automatic stop; it rather seemed as though an adverse signal had unexpectedly been sighted. The explanation turned out to be that the young lady had inadvertently lifted her hand off the knob in the controller handle and that had automatically cut off the current and caused a service application of the brake. This is the safeguard known as the "dead man's handle," and would come into action should the motorman, who is alone in his cab, be taken ill.

A SERIOUS collision occurred outside Preston on the evening of Thursday, November 20th. A light engine had run round the Whitehouse curve in order to turn, and had arrived at Whitehouse South box to pass through the cross-over road there and set back towards Preston Station. Whether the engine did not reach the cross-over and the signalman opened the points in advance of the engine, or whether the signalman called the engine back without opening the points is not known, but it set back on the facing road and was run into by a passenger train from Preston to Ormskirk. Both drivers were killed; the firemen, guard and two passengers were hurt. The Ministry of Transport's inquiry was subsequently held, and the adjourned coroner's inquest on Thursday, November 27th, when a verdict of "accidental death" was returned and the provision of a signal at the cross-over recommended.

WORK in connection with the electrification of the Cape Town-Simonstown suburban line is now being undertaken. Approximately 4 miles of track have been relaid, resleepered, and strengthened by the insertion of chair plates. The work is now being continued and involves some 32½ miles of track. The electrification of the Glencoe-Maritzburg portion of the Natal main line is proceeding satisfactorily. At the Colenso power-house boilers Nos. 1 and 2 have been tested. The erection of the remaining six boilers is nearing completion. In the engine-room No. 1 turbo-alternator has been run on test and No. 2 and the erection of the switchgear are practically completed. The installation of machinery at all the sub-stations is making rapid progress. Fourteen of the electric locomotive units have been tested and work on the erection of forty others is nearing completion. On October 21st a train of approximately 1419 tons was hauled from Ladysmith to Chieveley by three electric units, the number which will ordinarily be used to haul heavy goods trains on severe gradients of this nature.

Notes and Memoranda.

UP to the beginning of October the total quantity of ground washed at the Premier diamond mine amounted to over 102,000,000 loads, and from this 23,510,620 carats of diamonds, valued at £26,145,476, were recovered. The weight of this output was 6¼ tons.

WHAT is said to be the world's largest zinc mine, the Sullivan mine, which is near Cranbrook, B.C., is stated to have undeveloped ore equal to an output of 1,000,000 tons annually for forty years. The zinc-lead ore is running over 20 per cent., and the mine is estimated to contain 70,000,000 dollars worth of ore.

THE official report on a recent water-tube boiler explosion is noteworthy on account of the fact that the tube which failed was American made and lap-welded charcoal iron. The accident was caused by a defective weld. British-made tubes in the same boiler, and in more exposed positions, were quite satisfactory.

IN commenting on the explosion of the boiler in a small coasting steamer, the engineer surveyor-in-chief, Board of Trade, remarks that the explosion, although not serious in itself, was somewhat peculiar in the fact that the shell plate was pitted right through from the inside in a position remote from any of the riveted seams. It is not very clear why the attack should have been so local, but possibly the circulation was not good there, and whenever the water is stagnant in a boiler, pitting usually occurs.

ACCORDING to the report of the South African Department of Mines and Industries, an average of 18,756 white men were in employment on the gold mines of the Rand during September, and on the last day of the month they had increased to 18,835, which is a record for the industry since the 1922 strike. The total amount of money disbursed to European employees of the large gold mines of the Witwatersrand during September is stated to have been £576,454, including £23,924 as leave pay.

GELATINE cannot be used in the same way as glue, because a solution sufficiently concentrated (25–30 per cent.) to fill up the space between the surfaces to be joined is, when cold, too viscous and sets too rapidly to penetrate into the pores of the material. This can be overcome, the *Chemical Trades Journal and Chemical Engineer* states, by applying first a 6–7 per cent. solution at 55–60 deg. Cent., and a few seconds later a 20–22 per cent. solution in a thick layer, and quickly pressing up. Such a joint is stronger than one made with ordinary glue. Gelatine liquefied by chloral hydrate is well adapted for household purposes. It can be made very concentrated and used cold and is almost colourless.

MUCH interest is still being taken in the future construction of a deep-sea harbour at Semarang, Netherland East Indies, and a special committee appointed to investigate the subject reports that both technically and financially the building of a new harbour is feasible, and most desirable in the interests of the port's shipping and trade. The total cost is now estimated at 15 million guilders. A further million guilders will be required for additional works, apart from actual harbour construction, but these will only be carried out when it has been definitely ascertained that they will prove remunerative. The basin will be 170 hectares in area, with depths of 10 m., 8 m. and 7 m., and accommodation for 28 ships.

EXPERIMENTS have lately been made under the direction of the Director of Chemistry in connection with the utilisation of South Australian brown coal in a producer gas plant, and the results are reported to have been highly promising. The coal has been gasified in an up-draught producer, and the tar extracted. The cleaned gas has run a gas engine continuously for a month. Some modifications are being made in the gas plant as a preliminary to further experiments, and, in addition, it is considered desirable to obtain a down-draught producer, and conduct a series of experiments with the gas produced by it. It was found that the lignite gave 3.336 lb. of steam from and at 212 deg. per pound burned per hour. The test showed that 2.82 tons of lignite were required to furnish the same amount of heat as one ton of Newcastle coal.

WITH the object of taking regular observations of the apparent radio bearings of various transmitting stations, it was decided towards the end of 1920 to erect a number of directional radio receiving sets in various parts of the British Isles. These were placed by the Directional Wireless Committee of the Radio Research Board under the supervision of Dr. R. L. Smith-Rose, whose first report on the results has just been issued. Ten observing stations were set up in 1921, seven of them being situated at British universities, and the work was continued until this year. The report deals with the work during the first year, when observations were confined to those in fixed stations operating on wave lengths between 2000 m. and 9000 m. Some 41,000 readings were received and are summarised. Later investigation was extended to much shorter wave lengths.

LECTURING before the Birmingham branch of the Institute of British Foundrymen at Dudley recently, Mr. C. Dickens stated that pure aluminium was not much used for castings because its elongation was too high and its tensile strength too low. It was usually necessary to alloy it with other metals, and Specification L5, laid down by the Air Board, provided for a content of 2.3 per cent. copper and 12.14 per cent. zinc. The product was an alloy used considerably in the automobile trade for crank cases and gear-boxes. Sand cast, this alloy had a tensile strength of 10 tons and an elongation of 6 per cent. When chill cast, the figures were 14 tons and 4 per cent. respectively. Alloy L11, containing 7.8 per cent. of copper and 1.2 per cent. of zinc, withstood fairly high temperature, and was useful for cylinders. L8, containing 88 per cent. of aluminium and 12 per cent. of copper, was shown as "piston alloy." Chill cast, it had a tensile strength of 10 tons and an elongation of 1 per cent. An alloy of aluminium with 5.13 per cent. of silicon possessed advantages from the point of view of casting, feeding, and avoidance of porosity. Another alloy which had been used with success in permanent moulds contained 92 per cent. of aluminium and 8 per cent. of copper. It had a tensile strength of 11 tons and an elongation of about 3 per cent.

Miscellanea.

THE production of caustic soda and chlorine by electrolysis is being undertaken at Yarraville, Victoria, by the Mount Lyell Chemical Works.

IT has now been definitely decided that an exhibit will be arranged by H.M. Government at the New Zealand and South Seas Exhibition at Dunedin in November, 1925.

A TRAIN ferry has been put in service at Grafton, on the Clarence River, New South Wales. She is 214ft. long by 33ft. beam and originally belonged to the Sydney Harbour Trust.

THE Corporation of Calcutta is inviting tenders for an electrically driven sewage pump capable of raising roughly screened sewage at the rate of 2½ million gallons per hour against a head varying from 3ft. to 17ft. The electricity supply is three-phase current at 6600 volts and 50 cycles.

NEW contracts for amounts totalling over £100,000 have been let in connection with the duplication of hydro-electric works at Lake Coleridge, New Zealand. Tenders are to be called for a duplicate line to Timaru and for extensions to Oamaru. The estimated cost is between £57,000 and £58,000.

A REPORT from Madrid states that the question of unifying the Spanish electrical system is being studied, and plans are to be drawn up for obtaining the necessary funds. A move is being made towards developing the Catalan hydro-electric installations, which may lead to a decline in the use of coal in that region.

IT is reported that the Han Yeh Ping Company, the owners of the large ironworks at Hanyang, China, is in financial difficulty. Tokyo papers report that an understanding has been arrived at between the company and the Yokohama Specie Bank for an advance of 8,000,000 yen, and say that the company is already indebted to Japan to the extent of 30,000,000 yen.

THE Nottingham City Council recently gave unanimous first reading to a proposal to build a new town hall on a site fronting Great Market-place, at present occupied by shambles. A palatial new building will be erected which will cost £600,000. An arcade of shops and offices will produce rentals which, it is estimated, will entail less than a penny rate levy for sixty years from the erection of the building.

IT is reported from Delhi that the Government of India has decided to ask the Legislature in January to agree to grant the steel industry in India a bounty limited to fifty lakhs of rupees a year. It rejected a proposal to enhance the protective duty on the ground that it would entail a heavy burden on the consumer. It is estimated that the bounty will amount to twenty rupees per ton of finished steel produced in India.

THE Main Committee of the British Engineering Standards Association has recently authorised the secretary, Mr. le Maistre, to accept the cordial invitation of the German Standards Committee (the N.D.I.) to be present at its annual meeting on December 13th. Mr. le Maistre is also going to Prague to give an address on "Industrial Standardisation" before the recently formed Czecho-Slovakian Standards Committee.

ACCORDING to a statement made by the Spanish paper *El Liberal*, an agreement will shortly be signed under which the mines and factories at Mieres (Asturias) will be under the control of Messrs. Krupp. The scheme involves the establishment of a new company with a share capital of 50,000,000 pesetas and a like amount of debentures. Messrs. Krupp, it is stated, would not hold the majority of the shares issued, but would be charged with the technical control of the enterprise.

THE Secretary for Mines announces that with a view to bringing information about accidents due to the use of electricity in mines more readily to the notice of those engaged in the mining industry, the Mines Department has issued the annual report of the Electrical Inspector of Mines for 1923 as a separate publication, instead of incorporating it in the annual report of the Chief Inspector of Mines. Copies of the publication may be purchased, price 6d., by post 6½d., through any bookseller or directly from H.M. Stationery Office.

THE China International Famine Relief Commission proposes to construct a flood channel from a point south of Tientsin to the sea, a distance of 45 miles, to supplement the Hai Ho River, which is now the only outlet to the ocean, thus removing Tientsin beyond the danger of inundation and draining an immense territory in Chihli province. It is estimated that the entire cost of the work will be about six million dollars, with the possibility of employing famine labour, but the scheme depends upon whether adequate funds are placed at the disposal of the Commission, as, for instance, the proposed Maritime Customs surtax.

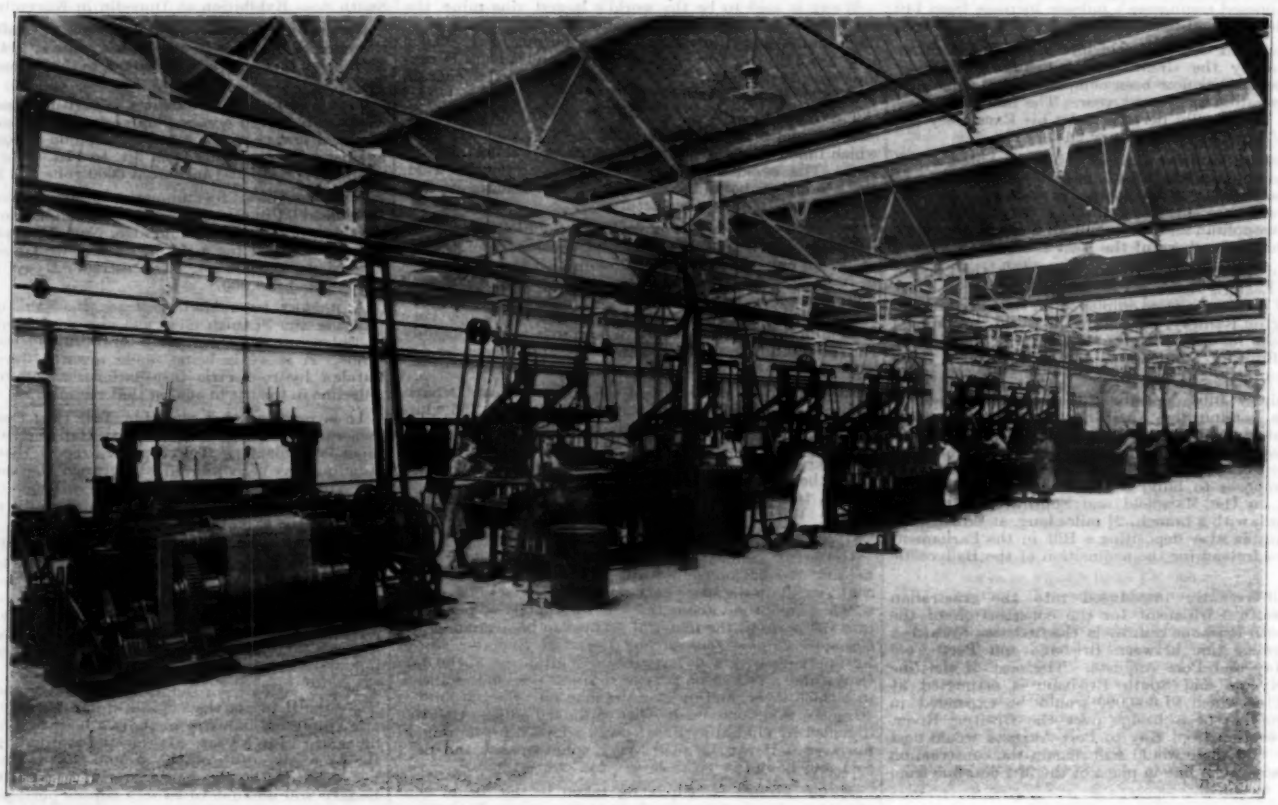
BY the end of the year Italy will be connected from the Alps to Sicily by a distributing system to which most of the power stations will be able to furnish current. A powerful group, financed by the Banca Commerciale, representing a capital of over 1500 million lire, will supply current from the Adamello Company in the Alps and the Terni Company in Central Italy to the Sila in Calabria and the Generale Elettrica in Sicily. Another important combination, headed by the Edison Company and including the Negri Company, with a combined capital of 1000 million lire, is fast completing a hydro-electric system associating many power companies operating in Lombardy, Piedmont, Liguria and Emilia.

THE first Radio Club to be founded in Poland, states the *Wireless World and Radio Review*, is that just organised in Poznau. The main object of the club is to arouse interest in wireless communication throughout Poland, and to foster the development of the radio industry. In addition to holding lectures and demonstrations, the Poznau Wireless Club itself will sell radio apparatus and appliances, on a commission basis. As the wireless industry is in its infancy in Poland, there is evidently a big scope for British manufacturers, though competition from German makers will doubtless be very keen. The club will also publish a magazine dealing with, explaining, and encouraging the use of wireless installations in Poland.

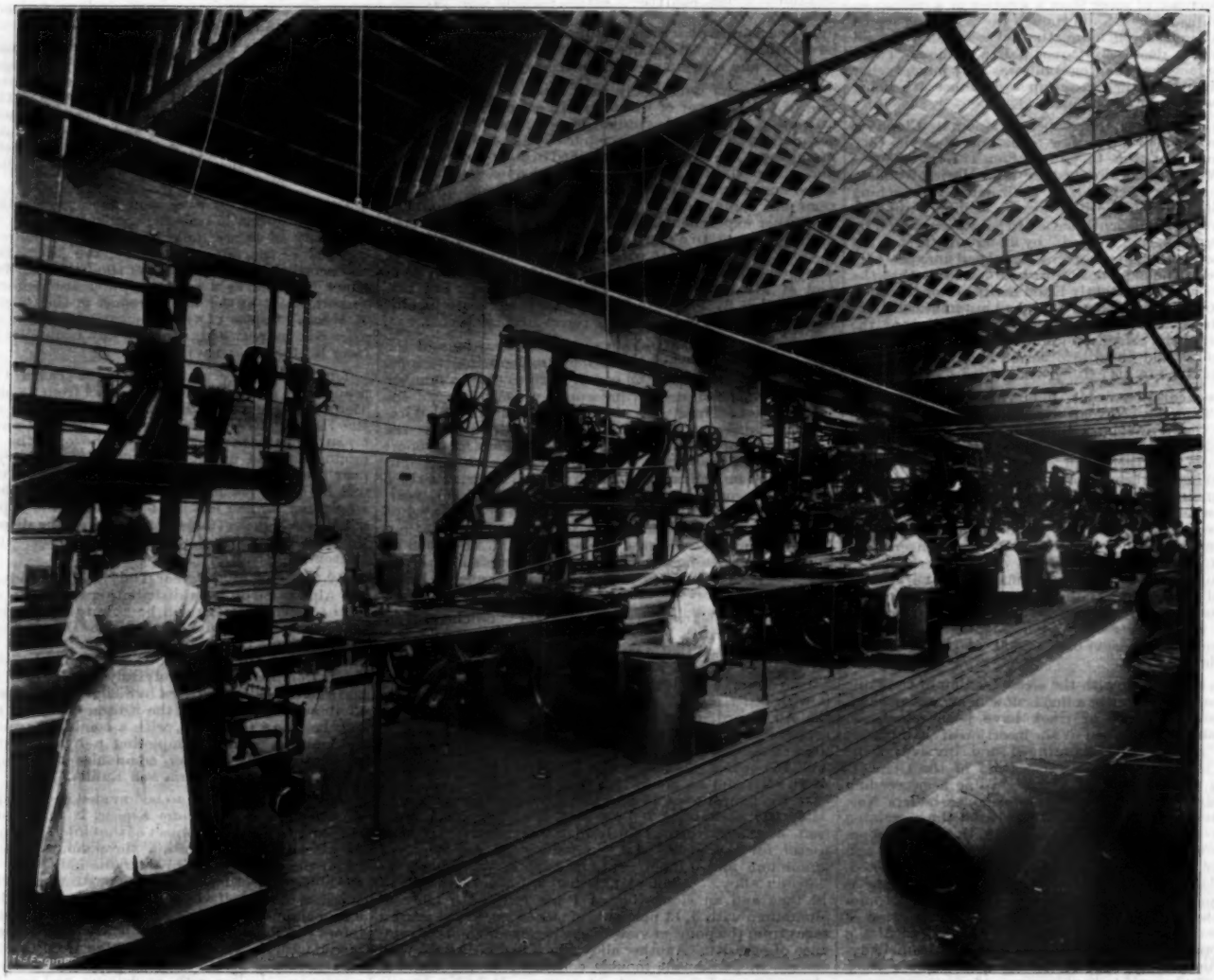
A MODERN WIRE-WEAVING SHOP

RICHARD JOHNSON, CLAPHAM AND MORRIS, LIMITED, MANCHESTER, ENGINEERS

(*For description see page* 637)



BOBBIN WINDING DEPARTMENT



A ROW OF McGEE WIRE-WEAVING LOOMS

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The Engineer

BUENOS AIRES.—Mitchell's Book Store, 576, Cangallo.
CHINA.—Kelly and Walsh, Limited, Shanghai and Hong Kong.
EGYPT.—Cairo Express Agency, near Shepheard's Hotel, Cairo.
FRANCE.—Boyveau and Chevillet, Rue de la Banque, Paris.
Chapelot and Cie., 136, Bld. St. Germain, Paris.
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The Engineer can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

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Teleg. Address, "Engineer Newspaper, Estrand, London."
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THE ENGINEER.

DECEMBER 5, 1924.

Lost Torque in Marine Engines.

Among the many features of interest contained in the first report presented by the Marine Oil Engine Trials Committee, none is of greater practical and theoretical importance than the revelation which it makes of a large and unexplained discrepancy between the torques in the propeller shafts, as measured by torsionmeters and as estimated from the indicated horse-power and mechanical efficiency of the engines. As recorded in our issue of last Friday, the Moullin torsionmeter on the Sycamore's port shaft during the full-power trial indicated an average torque of 37,600 lb.-ft. The average indicated horse-power determined from cards taken every half-hour during this four hours' trial at sea was 1486. The mechanical efficiency of the engine as determined on shore by the measurement of the brake and indicated powers was 74 per cent. The torque at the fly-wheel equivalent to the indicated power at sea was thus 45,500. The torque as measured by the torsionmeter was therefore 17 per cent. less than the estimated torque at the fly-wheel. This discrepancy is the smallest one revealed in the report. In the case of the starboard shaft—which, it should be noted, was fitted with a Hopkinson-Thring torsionmeter—the discrepancy during the high-power trial was 22 per cent. During the lower-power trial the discrepancies were still greater, amounting to 23 per cent. in the port shaft and 27 per cent. in the starboard. In all four instances the measured torque was lower than the estimated. If this loss of torque be genuine, and if it can be established as a general phenomenon, no word of ours is required to emphasise its importance. If it be not genuine, it is still important to trace its cause, in order that we may know exactly where we stand and what relative value to attach to the shore and sea trials of marine engines in the future. To discover the truth of the matter in this respect, we have made a diligent study of the report, but we find ourselves still unable to offer any sound and satisfactory explanation of the whole of the missing torque.

Without much more evidence than is afforded by the report, we are not prepared to accept either of the easy, if extreme, explanations of the discrepancies, which have been advanced by Mr. Moullin and Mr. Westgarth. Mr. Moullin will not admit any serious source of error in his torsionmeter, and is of the opinion that the lost torque is to be accounted for by a decrease in the mechanical efficiency of the engines, resulting from their installation on board the vessel. Mr. Westgarth will not hear of such an explanation, and lays the blame on Mr. Moullin's torsionmeter. Our investigation suggests that the discrepancies are far too large to be traced to either of these sources, or even to both of them acting simultaneously. The Moullin torsionmeter measures the twist of the shaft in two planes, 4ft. 6in. apart, by means of an electrical coil, the self-inductance of which is caused to vary with the twist. The conversion of the twist into terms of torque requires, as usual, either a direct calibration of the shaft or a fairly accurate knowledge of its modulus of rigidity. The calibration undoubtedly affords an opportunity for the introduction of an error, but that such error could be as great as one part in four is simply unbelievable. The evidence for the loss of torque does not rest solely upon the readings of the Moullin torsionmeter. It is supported, even reinforced, by the readings of the Hopkinson-Thring torsionmeter on the starboard shaft, an instrument of different design and employing a different principle. It appears therefore that if we condemn the Moullin torsionmeter as an instrument liable to give an error of 25 per cent. or so, we must equally condemn the Hopkinson-Thring device and for that matter all other torsionmeters which operate by endeavouring to measure the twist of the shaft. Actual tests with the Moullin torsionmeter, the inventor has said, show that the torque it records agrees with the torque deduced from a band brake test to within a few per cent. Tests of this description appear to have been very seldom carried out, but in no case which we can trace has a torsionmeter behaved in the suicidal manner suggested in explanation of the Sycamore figures. But if Mr. Westgarth's argument overshoots the mark, so, too, we feel, does Mr. Moullin's. Some loss of mechanical efficiency must, of course, be expected to result from the transference of the engine from the steady, unyielding floor of the test shop to the flexible, rolling and pitching base provided by the ship. But that the change could reduce the efficiency from 74 per cent. to 62 per cent.—the figure required to meet Mr. Moullin's argument—is again unbelievable. Moreover, in so far as this suggested loss of mechanical efficiency is to be ascribed to the working of the ship's hull under the stress of wind and waves, the report itself defeats the argument very thoroughly. During the full-power trial the vessel was pitching four or five feet at the bow and stern. During the low-power trial, the wind was astern and pitching was almost absent. Yet the lost torque was greatest during the low-power trial, when, presumably, the working of the hull was least. If, then, the mechanical efficiency suffered by the installation of the engines on board the vessel, it must have done so primarily as a result of faulty alignment of the main and the propeller shaft bearings, a suggestion which, in view of the magnitude of the loss involved, the builders may justly resent. Even although we could reasonably and without giving offence, adopt this view, we would have to square it with the fact that the faults of alignment were such that their effect in reducing the torque was lessened and not increased by the working of the ship's hull under stress of weather.

As an alternative to Mr. Moullin's and Mr. Westgarth's views it might be suggested that the apparent loss of torque is to be traced not to one especial and particular cause, but to the cumulative effect of a variety of small errors and omissions. In accordance with this suggestion, let it be supposed that during the full-power trial the Moullin torsionmeter on the port shaft was reading 3 per cent. too low and that in the four bearings and the thrust block between the torsionmeter and the engine fly-wheel 2 per cent. of the engine power was being lost. Let it be further supposed that the mechanical efficiency of the engine had suffered an installation loss of 2 per cent. Finally, let it be supposed that the indicated horse-power, as determined at sea, was 5 per cent. too high, and that the mechanical efficiency, as measured on shore, was likewise 5 per cent. on the high side. All these figures are of reasonable magnitude. If we accept them the 17 per cent. discrepancy between the measured and the estimated torques vanishes, and the two, taken at the engine fly-wheel, come into agreement at about 39,600 lb.-ft. This method of accounting for the lost torque seems both simple and reasonable, but there are two arguments against it, either of which is sufficient to put it completely out of court. In the first place, if we apply the same percentage corrections to the figures for the starboard engine during the low-power trial, the original discrepancy of

27 per cent. does not disappear, but remains at a perplexingly high figure—about 17 per cent. To cause this residual discrepancy to vanish, we would have to double, or more than double, our correcting factors, a step that would make them unreasonably high, and that would by itself be irrational. In the second place, even if we accept the magnitude of the correcting factors as reasonable, their relative signs will not bear examination. The spurious agreement between the measured and the estimated torques, which they produce, is dependent chiefly on the magnitude and sign of the supposed errors in the indicated horse-power measured at sea, and the mechanical efficiency measured on land. Both these errors have been taken at 5 per cent. on the high side. Such a concatenation is most unlikely, particularly if, as we believe was the case, the same indicator and indicator rig were used at sea as on shore. If the indicated horse-power at sea was 5 per cent. too high, we must reasonably assume that it was something of the same order too high on land. Such an error would make the mechanical efficiency some 5 per cent. too *low*, with the result that the two errors would cancel and not reinforce each other as we have supposed. As a means of accounting for any portion of the lost torque, errors in the measurement of the mechanical efficiency and the indicated horse-power are thus of no avail, provided we assume, as we seem reasonably entitled to do, that the errors in the measurement of the indicated horse-powers at sea and on shore were of the same magnitude, and in the same direction. To what item in the count are we to attach the error of some 10 per cent., which is thus set free for assignment? The brake horse-power, as measured on land for the purpose of determining the mechanical efficiency, would serve. We cannot believe, however, that a Heenan and Froude brake would misbehave itself to such an extent. Still less can we believe that it would change its error to over 20 per cent. when the power was reduced to that corresponding to the slow-speed sea trial.

From these studies, the only conclusion we are prepared to draw with any assurance is that the information given in the Committee's report, voluminous though it be, is still insufficient to enable us satisfactorily to assign the cause of the lost torque. The chief omission, it would seem, is that of detailed data showing the variations in the readings obtained for each individual item measured. Practically all the figures in the report, including those with which we have been working, represent the averages of series, and to this fact much that now seems mysterious may owe its ultimate explanation. The process of averaging is sometimes a dangerous and misleading one, particularly when the object aimed at involves the multiplication or division of one or more averages by another. It is, for instance, quite contrary to the fundamental principles of the integral calculus to suppose, as is very frequently done, that the average value of a product is the same as the product of the average values of the separate factors. It is definitely different, and only by chance will the two processes yield results that are in fair agreement. To the hidden operation of some such mathematical fallacy the lost torque revealed in the trials of the Sycamore may perhaps owe its origin. If such be the case, the loss is not a genuine one; that is to say, no efforts of the engine or shipbuilders towards improvement will succeed in reducing or eliminating it. Nevertheless, even though it be not a genuine loss, we must seek the cause leading to its presentation, in order that the trials and all others of a similar nature conducted in the future may have any value in practice. On the other hand, it cannot be denied that there is little reason and practically no evidence against believing that the lost torque is genuine. Certainly there is opportunity for a definite loss to occur. It is no argument to say that were the loss genuine it would have been detected or at least suspected long ago. When it was possible to indicate the marine engine, the torsionmeter was not in existence. When the torsionmeter became a practical instrument, the marine engine to which it was almost exclusively applied was of the turbine type, which cannot be indicated. Its indirect revelation, unless its existence were strongly suspected, would be obscured in a variety of ways. For example, any discrepancy which it might cause between the actual performance of a vessel and that predicted for her from model experiments, would be unwittingly compounded in the scale effect and passed over as a separate factor. However we look at the subject, its importance is great. With something of impatience, we await the succeeding reports of the Committee, in order that it may be examined in the light of additional evidence obtained from the trials of other vessels and other engines.

Railway Electrification.

The method of electrifying railways described by Mr. Verebely in an article which we publish on another page is the outcome of an endeavour to find a system which is cheap to install and economical to operate. The conditions prevailing in Hungary will not permit of the adoption of a system which involves changing the primary current into another kind of current in rotary converter sub-stations or the erection of power stations solely for supplying the railways. As we mentioned in an article on this subject in our issue of November 30th, 1923, it is proposed to feed the railways with single-phase 50-cycle current from the general three-phase system, a scheme which, according to Mr. Verebely, is in conformity with the conclusions arrived at, and expressed unanimously by some of the best-known English and American electrical experts at the recent World Power Conference. The conclusions apparently were that in the future, when main-line electrification is undertaken on a large scale, a system must be aimed at which will avoid the present necessity of using a special railway current and which will enable the electrified railways to draw their supply directly from the 50-cycle power stations without the intervention of sub-stations equipped with converting machinery.

Obviously, if this is what electrical engineers are now aiming at, the question of using direct current on the railway distribution systems can be dismissed. We have always contended that main-line electric trains should be fed with alternating current, and although there has been a good deal of argument to the contrary, it now appears that the advantages of high-pressure distribution for long-distance work are beginning to be recognised. If Mr. Verebely's scheme will do all that he claims for it, then the latest argument against the use of single-phase current is no longer of any importance. Single-phase working has been attacked from many angles, but within recent years, the main, and perhaps the most formidable, argument against it has been that it necessitates a supply of current at a low periodicity, and that separate generating stations or special low-periodicity machines in the 50-cycle stations or frequency changers in sub-stations are therefore essential. But the method of electrifying main-line railways described in Mr. Verebely's article overcomes the difficulty. The railway load can be combined with the industrial load, and all the alleged benefits of the combination can be secured. Incidentally, the practice of combining the two loads is not universally regarded as desirable, but that is a matter into which we need not enter. Of course, the idea of collecting single-phase current and turning it into three-phase current on the locomotives is not new. Split-phase 25-cycle locomotives have been built, and are still being built, for heavy goods and mineral service in America. The difference between the American and the Hungarian schemes will, however, readily be understood, the most important feature of the latter being, of course, the collection of 50-cycle current from the individual phases of the general supply system. The doubts that have been expressed as regards the possibility of obtaining a sufficiently good balance on the three-phase system do not seem to be troubling the Hungarian engineers in the least. Although the experimental locomotive described in the article is supplied with current from quite a small station, the out-of-balance current does not appear to interfere with the regulation, and if a more extensive scheme of electrification is undertaken, the load will be much more uniform because the traffic will be more dense, and it will be possible by properly sectionalising the electrified zone to distribute the load satisfactorily on the three phases. No doubt it will be pointed out by those who are opposed to the use of alternating current on railways that the scheme does not avoid conversion, which is perfectly true. It does, however, give us a simple and economical high-pressure distribution system, working at a high power factor. No rotary converter or mercury vapour or frequency-changing sub-stations are needed, for all the conversion is done on the trains. The phase converter which is employed for this purpose seems to be quite a simple affair, which should not be unduly heavy. What the overall efficiency of these new locomotives is we do not know. Taken as a whole, however, the system would seem to offer advantages over the more orthodox systems. It is improbable that it constitutes the final solution to the main-line electrification problem, but it is certainly a scheme worthy of consideration. Just recently we have heard that a well-known firm is developing a 50-cycle single-phase traction motor. The design of a machine of this kind is a task of no mean order, and it remains to be seen whether the difficulties involved can be overcome. In any case, a better method of electrifying main railways than that which British engineers propose to adopt ought to be sought.

Those who imagine that the Americans no longer propose to use alternating current on their railways are very much mistaken. A writer of a letter in our correspondence columns stated some time ago that the largest American electrical firm had given up the manufacture of alternating equipments. But what are the facts? This particular firm has recently received an order from the New York, Newhaven and Hartford Railroad for seven "alternating-current direct-current locomotives," whilst another large American electrical concern is dealing with an order for similar locomotives designed for a pressure of 22,000 volts, for the Ironton Railroad Company. How anyone can imagine that the exceptionally heavy trains on some of the American railways can be worked satisfactorily without alternating current is beyond our comprehension. The collection of the current is quite sufficient to warrant a higher pressure than is practicable with the direct-current system. These new 11,000 and 22,000-volt locomotives are equipped with motor generators which convert the single-phase current into direct current, which is supplied to the driving motors. The principle is very old, but it is worthy of note that although the idea was abandoned in the past on the score of weight, motor generator locomotives have been found to weigh no more than 3000-volt locomotives. We do not believe for a moment that the motor generator locomotive has come to stay. It will probably be found in due course that it is possible to use a light, relatively cheap and efficient rectifier, such as a mercury vapour or thermionic rectifier. Certain it is, in any case, that high-pressure alternating-current distribution is the right thing for main lines. As a well-known consulting engineer in America said in a recent letter to us in connection with this important subject, the single-phase system is the only system which is suitable for all kinds of work under all conditions, and if it is possible to adopt it without employing frequency changers or special generating plant, then, in our opinion, it is inexpedient to be in too great haste to electrify the main lines of this country in accordance with the scheme that has been proposed.

Literature.

John William Strutt, Third Baron Rayleigh. By his Son, Robert John Strutt, Fourth Baron Rayleigh. London: Edward Arnold and Co. 1924. Price 25s.

No one will deny that the first duty of a biographer is to lay before his readers the portrait of a human being. Whatever else he may do, however much he may be concerned with the works of his subject, unless the human attributes form the canvas on which his design is worked out, he fails in his craft. He may give us a treatise on philosophy, on law, on religion, on science, on politics, but if the man himself does not shine through all that he did, the book will remain a treatise, and never become a Life. Judged by this universally accepted standard, Lord Rayleigh's Life of his father must be accorded a high position. We have heard it said that it does not exhibit clearly enough the sweetness of disposition of the great scientist; that it says too little of the many good actions that he did. It may be so to those who knew him as intimate friends; but it is only few of those who read his life who enjoyed that high privilege. To most, he is a distant figure in the highest realm of science, and they will be grateful to his biographer for the many touches by which he reveals his human side.

Yet we doubt if many will care to spend much time over his boyhood and youth. There was not much in them, as far as we can see, that was out of the common. The apothegm that the "boy is father to the man" must not be pressed too far. Were it universally true, the world would be composed of Rayleighs, for the early proclivities for science which Lord Rayleigh displayed are found in nearly all boys, and in many in a far greater degree. It would not be right to say that he drifted into the pursuit of science rather than that he set out upon it with fixed intention; yet he did not make those preparations for a scientific career that are made by young men of the present day. He went to Cambridge in the early

'sixties of last century at a time when the University flirted with science through the offices of mathematics, but when classics still held their position almost unchallenged. In the vacation he devoted himself to experiments on light, and became a keen photographer, but at Cambridge there were no laboratories, and all he learnt about experimentation he picked up at the lecture table from Stokes. One may suppose that this lack of early training was responsible for the untidiness of his laboratory methods in later days.

In 1865 he was senior wrangler, and in the following year secured a fellowship. Thereafter, he was free to go his own way, and devoted himself to experimental science, largely at Terling, in Essex, the family estate. His biographer gives us an interesting account of his laboratories and study there. They were what one must call makeshift, and throughout a domestic atmosphere covered them. His work, unlike that of most of us, was just part of his home life. He stepped from his study—in which Lady Rayleigh had a desk—into his laboratory, where the faithful Gordon was busy, and stepped from the laboratory into the dining-room or met his steward to discuss the affairs of the farm. He lived with his work, and his work lived with him. There is a charm about such conditions, and perhaps we shall not be far wrong if we suppose that it was because of them that he retained that human touch which shines through his biography and which endeared him to a large circle of friends in many different spheres of life—politicians, literary men, psychologists, scientists, engineers.

We have alluded already to Rayleigh's early devotion to optical problems, and it may be recalled that for nearly eight years, from '71 to '79, he gave a large portion of his time to gratings and the resolving power of spectroscopes, but his greatest work was done in another field. In the early 'eighties he began an investigation into the relative densities of hydrogen, oxygen and nitrogen, with the object of proving or disproving Prout's law that the atomic weights of gases stand in simple relationship to that of hydrogen. The problem gave him a vast amount of trouble, and many years elapsed before he was satisfied that his results for hydrogen and oxygen were trustworthy. As is now well known, they showed that Prout's generalisation was inaccurate. It was not till 1891 or 1892 that he began the weighing of nitrogen, and that he started, lightheartedly enough, upon what appeared to him to be a relatively simple problem, but which eventually led to the famous research which resulted in the discovery of Argon. There is no better chapter in his biography than that which describes this long inquiry. It must remain to the end an invaluable record in the history of chemical science, and alone it is sufficient to establish the work before us. As both men have now passed away, one may openly express regret that Sir William Ramsay "poached" upon a preserve which Rayleigh had staked out, but there can be no manner of question, after reading the present Life, that the real honour of the discovery belongs to Rayleigh. It was, if not the climax, certainly the most remarkable achievement of his scientific career. After its conclusion he engaged in numerous other researches, but other duties—social, political and educational—seemed to crowd in upon him, and less and less time could be given to his laboratory at Terling.

His son and biographer has the advantage of being himself a scientist and of having witnessed much of the work done by his illustrious father. He has, moreover, an easy pen and a natural ability for laying before the general reader a simple account of difficult matters. His volume does not demand the scientific reader; it may be read and understood by all and sundry, and they must be few indeed who do not find use and entertainment in it.

The Merchant Navy. Vol. II. Being a section of the History of the Great War based on official documents and prepared by direction of the Historical Section of the Committee of Imperial Defence. By Archibald Hurd. London: John Murray. 1924. Price one guinea net.

There has been considerable comment upon the fact that this, the second volume of the history of the merchant navy during the war, has been so long in preparation, as it had not appeared some time after the third volume of the companion history of seaborne trade, written by Mr. C. Ernest Fayle, had been issued. It takes the history down from the sinking of the Lusitania to the eve of the intensive submarine campaign. It is not as successful as its predecessors, and it cannot be described as being up to Mr. Hurd's usual standard. Many of the accounts hang heavily and revive unpleasant reminiscences of the official announcements of the war period. This is the more disappointing as Mr. Hurd was practically the only one of the naval experts continuing to write during the war who saw clearly the importance of merchant shipbuilding to the country, and who, in spite of every discouragement, steadily advocated its pursuit, even when the Government could only see the immediate needs of the moment and was concentrating on naval work without realising the inevitable trend of the war at sea. The justification of his ideals and advocacy would seem to have offered the writer an ideal field for some of the fine work of which he is capable, yet one cannot but regret his book as a curious mixture of the broad and the minute, chapters being devoted to single ships, while the exploits of the three surface raiders, which are of such colossal importance to the students of the possibilities of naval warfare in the future, only receive one.

But apart from these points, the author presents to the public for the first time a mass of invaluable information that is well worthy of careful study. He knows his subject thoroughly, and with the assistance that has been put at his disposal by the various authorities has contrived to present facts in a manner that will be entirely novel to many laymen who are willing to be interested in the history of sea warfare. He begins with the intensification of submarine warfare which opened with the sinking of the Lusitania, and goes on to give some account of the operations of the Auxiliary Patrol to counter the evil. The fishermen's part in this work is especially noted, and is very well worthy of the attention it receives. The paddlers, too, come in for their meed of praise, and the fights that some of these supposedly paper boats put up make fascinating reading. The transport operations are carefully analysed and this chapter is particularly valuable. The enemy's mine-laying work and the measures that we had to take against it are also fully described, and numerous actions against submarines are recounted. With the careful manner in which the book is indexed, all this information is made easily accessible, and as one turns over the pages one comes across literally scores of interesting points that will have to be borne very carefully in mind in the next naval war.

Unfortunately, the book has not been carefully re-read and numerous misprints have been left in, which detract considerably from its value, especially when differing statements are made on successive pages. They are obvious misprints, but there are so many of them that they become rather a serious matter. But despite all, the book is an exceedingly valuable addition to the literature of the sea, and it is to be hoped that the third volume will be put before the public very shortly.

SHORT NOTICES.

The Design and Working of Ammonia Stills. By P. Parrish, A.I.C., M.I. Chem. E. London: Ernest Benn, Limited. 1924. Price 40s. net.—This is one of the excellent series of textbooks issued by the publishers of late years. As the title implies, the book is highly specialised and written for gas engineers and those in charge of coke ovens at ironworks. The consulting engineer, who, like one of Molière's characters, must be *capable de tout*, will also find this volume a valuable addition to his library. It would have been a great advantage if the many excellent illustrations had been dimensioned, an omission which is altogether too frequent, where the author is a chemist. For the sake of international circulation the mixing up of degrees Centigrade with B.Th.U. in the same tables ought to have been avoided. The theoretical and practical treatment of separation of dissolved gases by fractional distillation is thoroughly thrashed out, and working results are given as well as costs. Heat efficiencies and completeness of separations are all given with commendable attention to detail. The best judges of the value of this book are, however, the specialists who actually devote their time to this class of work as a routine, and the foreword by Dr. Charles C. Carpenter should be sufficient recommendation to them.

Marine Engineering in Theory and Practice. By Engineer-Commander S. G. Wheeler. London: Crosby Lockwood and Co. 1924. 18s. net.—Although there are already several standard works dealing with this subject in existence, it seems as if this new work should find a vogue among students and young men studying for their "ticket." The present is the first of two volumes and deals with the elementary side of the subject, while the second volume is to cover applied or practical matters. It starts away with the theory of heat and the laws of thermodynamics and goes on to discuss the ideal steam engine. The reciprocating engine is naturally given chief prominence, especially in connection with valve gears and indicator diagrams; but not to the exclusion of the steam turbine, to which two chapters are devoted. The book includes a number of examples for the exercise of students, together with the answers.

BOOKS RECEIVED.

Résistance des Récipients Soudés à l'Electricité. By E. Hœhn. Paris: Librairie Polytechnique Ch. Béranger, 15, Rue des Saints Pères, 15.

The Military Uses of Astronomy. By F. C. Molesworth. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 3s. 6d. net.

Mechanics of Textile Machinery. By W. A. Hantons London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 12s. 6d. net.

Le Vol à Voile Dynamique des Oiseaux. By M. L. Breguet. Paris: Gauthier-Villars et Cie, 55, Quai de Grands-Augustins Price 8 fr.

Der Sauerstoff. By M. Laschin. Halle a.S.: Carl Marhold Verlagsbuchhandlung, Wendt and Klauwell, Halle a.S., Germany. Price 3.60 goldmark.

Vanadium Ores. By members of the Scientific and Technical Staff of the Imperial Institute. London: John Murray, Albemarle-street, W. Price 5s. net.

Drawing Office Practice. By H. Pilkington Ward. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 7s. 6d. net.

Workshop Gauges and Measuring Instruments. By L. Burn. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 5s. net.

German Institution of Naval Architects.

We dealt briefly in our last issue with a paper by Dr. Flettner which was read at the recent meeting of the German Institution of Naval Architects. We now give *résumés* of two other papers presented on that occasion.

Gearing for Ships' Turbines and Motor Ships.

Dr. H. Frahm, of Blohm and Voss, Hamburg, presented a paper under this heading. There was, he said, no doubt that geared transmission was the most important development in ship propulsion which had been made during the last fifteen years. It had proved invaluable for reducing high turbine speeds to economical propeller speeds, and in a similar way it might be used with advantage with high-speed marine oil engines. Such engines, fully enclosed and fitted with forced lubrication, could be run at higher speeds than was possible with marine steam engines of the reciprocating type, and the marine high-speed oil engine could show a considerable saving in weight when compared with the reciprocating steam engine.

The author described the Reinecker type of gear tooth milling machine used at Blohm and Voss's yard, and gave particulars of the method adopted for preparing a master wheel and the cutting and testing of wheels and pinions. For pinion material an alloy steel with 3½ per cent. of nickel was employed with tensile strength of 63 kilos. per square millimetre (40 tons per square inch) and an extension of about 16 per cent. on a length of 200 mm. The wheels were built up by shrinking steel rims on to a cast iron body in the usual manner, and the rims were formed of Siemens-Martin steel having a tensile strength of 52 kilos. per square millimetre (33 tons per square inch) with an 18 per cent. extension. After making many tests with new gears heavily loaded it had been found, and was always to be recommended, that gearing should not be run under full load conditions until the teeth of the pinions and gear wheels were well bedded. For this purpose the gears were run over long preliminary periods and use was made of a fine abrasive material. Gearing efficiencies as high as 98.5 per cent. had been obtained. During the war geared turbines of large power were built by the firm for the cruiser Mackensen, and after the war two important geared turbine ships were the Hamburg-American liners Deutschland and Albert Ballin.—The geared turbine machinery of the latter ship was fully described in The Engineer of September 14th and 21st, 1923.—The use of gearing with internal combustion engines was influenced by the efforts which were made after the war to utilise high-speed submarine type engines for mercantile ship work. Direct gearing was particularly attractive by reason of its high efficiency of nearly 99 per cent., which stood out against the much lower overall efficiencies given by hydraulic and electric transmission.

Two of the first geared ships with high-speed marine oil engines were the Havelland and the Münsterland, ordered by the Hamburg-America Line. In those ships a ratio of transmission of 1 : 2.7 was used, and in order to obtain the necessary elasticity between the engine fly-wheel and the gearing hollow pinions were used and were driven by an internal shaft passing through the pinion and bolted to a coupling at the outer end of the pinion shaft. In order to take up the inertia at the moment of reversal, and particularly during manœuvring, automatic air brakes were fitted to the engine fly-wheels. The turning moment obtained was shown by experiment to be so constant that the Germanischer Lloyd agreed to the shafts being made according to the standard rules for turbine shafting. Good results were obtained from the two ships previously mentioned, and after lengthy tests had been made with them a third ship, the Vogtland, was ordered by the Hamburg-America Line, which likewise has given very satisfactory results. Comparative estimates of the cost of installing a 2000 brake horse-power four-cycle single-acting engine coupled direct to the propeller show that such an installation would cost about 418,000 marks and would weigh about 438 tons, whereas a geared oil engine for similar power would only cost about 290,000 marks and would weigh about 218 tons. The saving in engine-room space would also be very considerable. A particularly favourable case for the geared oil engine drive was when so arranged that two high-speed oil engines drove a single propeller shaft through a common speed reduction gear. This, the latest type of gear drive to be constructed by Blohm and Voss, is employed in the Monte Sarmiento, a 524ft. ship of 14,000 gross tons, built for the Hamburg-South America Line, which vessel left Hamburg on her maiden voyage early in November. In that ship twin screws are driven at a normal speed of 76 revolutions per minute by four six-cylinder four-cycle single-acting oil engines running at 215 revolutions per minute and designed to develop a total of 7000 shaft horse-power. From tests which were made it was decided that elastic hollow shaft couplings were unnecessary and they were accordingly done away with. In concluding his paper Dr. Frahm gave as his opinion that the double-acting two-stroke engine with port scavenging would in the future be widely

employed. Such engines could be directly coupled to the propellers or used with gearing, so that two engines would be coupled to a single shaft.

In an appendix the subject of vibration in the propeller shafting and in the engine itself was dealt with. Apart from torsional vibration, it had been found, he said, that longitudinal vibrations, probably resulting from periodical changes in propeller resistance or inequalities in the meshing of the gear teeth, might be set up. The instruments used for measuring such vibrations were described, and they included the author's special type of torsion indicator, an instrument designed to measure any lack of uniformity in the transmission of power from the engine to the propeller. In the discussion Director Goos testified to the very satisfactory results obtained with the Hamburg-America Line motor ships, and said that he shared the author's opinion as to the future importance of the double-acting two cycle marine oil engine. He was of opinion, however, that the method of power transmission must in every case be chosen to suit the particular circumstances of the ship under consideration.

Hydraulic-Mechanical Transmission Gearing for Motor Ships.

In a paper on the above-named subject Dr. G. Bauer, of Hamburg, dealt with the efforts which had been made to utilise fast-running oil engines for the propulsion of motor ships. One solution of the problem, he said, was the use of mechanical gearing. In a previous paper, he said—an abstract of which we give above—Dr. Frahm had described the geared installations built by Blohm and Voss, and in America similar mechanical gears had been built and successfully used by the Falk Corporation, of Milwaukee. Another solution of the problem was the introduction of a hydraulic-mechanical transmission gear, which system had been designed and tested by the Vulcan Works, of Hamburg and Stettin, under the patents of Professor Föttinger. In order to obtain results under actual working conditions an experimental ship, the Vulcan, was built and engined by the firm. In that ship two six-cylinder submarine type engines were employed and were designed to give a total output of 620 shaft horse-power when running at a normal speed of about 300 revolutions per minute. By the hydraulic-mechanical gearing, which is shown in the accompanying illustration, the speed of the engine was reduced in the ratio of 3.51 to 1, giving about 85 revolutions at the propeller. The Vulcan was a ship of 2000 tons deadweight and about 230ft. in length, and during a four months' run between North Sea ports and the Mediterranean Sea excellent results were obtained both with regard to manœuvring and reliability of running. Sailings had been made accurately to the time table, and there had been no stoppage of the machinery for repairs of any kind. The general arrangement of the Vulcan gear may be seen from the accompanying illustration. It will be noted that the single propeller is driven by two oil engines through pinions and a central gear wheel attached to the propeller shaft. The pinions are not directly coupled to the engine shaft, but when turning in the ahead direction the drive is transmitted through a hydraulic coupling without speed reduction, whilst when running astern a hydraulic transformer with a small reduction in speed is employed to reverse the direction of rotation. Both the transformer and the coupling are operated by oil and the wheel spaces are filled or emptied as required by transformer pumps driven by bevel gears on the pinion shaft. Manœuvring is accomplished by controlling the supply of oil delivered to the transformer and coupling wheels. The following figures may be taken as typical of the results obtained during voyages made with the motor ship Vulcan :—

Average speed of oil engines ..	307 r.p.m.
Speed of propeller shaft	87.5 r.p.m.
Ratio of speed reduction	3.51 to 1
Slip in the ahead coupling	2.5 per cent.
Efficiency of the wheel coupling	97.5 per cent.
Power at propeller shaft measured by torsion meter	580 S.H.P.
Oil temperature in transmission gear supply tank	43 deg. to 47 deg. Cent.
Maximum astern power	470 S.H.P.
Maximum turning effort ahead ..	5600 kg.m.
Maximum turning effort astern ..	4500 kg.m.

In view of the successful results obtained the following orders have been placed with the Vulcan Company :—A 490 shaft horse-power installation for a Bremer Vulcan tug, a 4100 shaft horse-power installation for a 9500-ton ship for the German Australian Line, and machinery of 3800 shaft horse-power for a cargo vessel ordered by the Hansa Line. Two 9500-ton ships for the Hugo Stinnes Line have also been ordered with propelling machinery of 3000 shaft horse-power, and a further set of machinery of 1600 shaft horse-power is under construction for the Wulsty Castle, which is to be built by William Beardmore and Co., Limited, of Dalmuir.

The general advantages of the hydraulic-mechanical transmission gear described may be conveniently summed up as follows :—

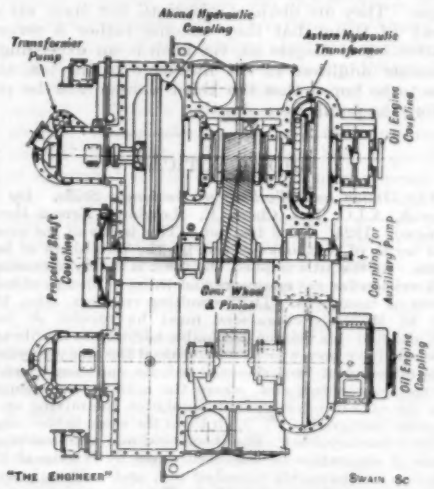
(1) The introduction of the hydraulic coupling between the engine and the propeller shaft prevents any periodical variation in the turning moment of the main engines being transmitted to the tunnel shafting, which shafting can therefore be designed to the same standards that are used in the case of turbine-driven ships. The oil engines can be designed with a crank shaft having a natural period of vibration well above the normal working speed of the engine. Furthermore, when slowing down the engines when manœuvring or in bad weather there should be no fear of having to pass through critical speeds with the accompanying heavy vibration.

(2) The system allows two oil engines to be coupled to a single propeller shaft in such a way that either can be disconnected at will. In the remote case of an accident to the main engines one can be shut down without stopping the propeller. Should it be desired to economise in fuel by running at a slow speed, one engine only may be run at an economic rating, instead of two engines at very low ratings.

(3) All machinery associated with manœuvring by compressed air, such as air compressors, reserve air compressors and air storage vessels, and piping is done away with, and there is no probability of the manœuvring being interrupted by the failure of air supply. The speed of manœuvring is increased, and a further advantage claimed is the non-introduction of cold air into the cylinders, with the consequent fall in temperature, giving rise to adverse effects on the temperature of the cylinders.

(4) The mechanical reduction gear permits of a low propeller speed being used with a high propulsive efficiency. With a propeller speed of 75 revolutions per minute, compared with 100 revolutions, such as is commonly employed with direct-coupled engines, a gain of about 12 per cent. in propeller efficiency may be obtained.

(5) Multi-cylinder engines may be used, giving better turning moments, smaller cylinders and higher speeds. Such engines have great advantages, both as regards construction and saving in weight. Tests which have been made recently show that the speed of the marine oil engine can be considerably increased without adversely affecting either the reliability of running or the life of the engines.



HYDRAULIC-MECHANICAL TRANSMISSION GEARING

In the concluding part of this paper Dr. Bauer showed by means of diagrams the great saving in size and height of the engine-room which the Vulcan system gave. In the case of a motor passenger liner with 40,000 shaft horse-power machinery eight two-cycle double-acting engines coupled in pairs to four Vulcan gears were shown driving two propeller shafts. Another design exhibited depicted a shallow-draught river steamer with four screws and machinery of 1100 shaft horse-power driving two Vulcan gears. In the case of a paddle-wheel motor ship two oil engines with a total output of 700 shaft horse-power would be placed crosswise in the ship. Dr. Bauer strongly opposed the view that the marine oil engine was unsuited for high-speed working and warned the oil engine builders not to be beaten by the designers of aeroplane and airship engines, who would certainly use the heavy oil engine for their own work.

In the discussion Professor Kluge agreed with the author with regard to the future of the high-speed oil engine. His own view was that the oil engine was more suited for use with transmission gear than was the steam turbine, for the smaller reduction in speed created better conditions for the gear teeth. The problem of the elastic coupling had been solved in a very happy way by the Vulcan gear.

Professor Hoff referred to the successful experiments which had been made in England with engines using heavy oils and designed for aeroplane and air ship work. He thought that the maximum weight allowable for such engines, including a six hours' supply of fuel oil, should be not more than 2 kilos. per horse-power.

Oberingenieur Gerhards spoke encouragingly as to the success of the high-speed submarine type of engine. The loss of 2.5 per cent. in the hydraulic coupling was, he said, more than counterbalanced by the other advantages of the gear. He considered that the doing away with the injection of cold compressed air into the cylinders during manœuvring was a most important advantage.

Oberingenieur Berendt exhibited a series of torque diagrams taken during the recent trials of the Hamburg-South America liner Monte Sarmiento, and showed that the results obtained indicated that in the case of a solid shaft arrangement vibration only took place at low speeds, and then only in a very small degree, indicating that a special elastic coupling was not really necessary.

Baurat Mohr agreed with the author as to the marked advantages conferred by the Vulcan gear.

In his reply to the discussion, Dr. Bauer mentioned that time occupied in reversing and manœuvring with the Vulcan gear could be reduced to any desired amount by suitable design of the gear. He was pleased to learn that in the case of the Monte Sarmiento vibration had been happily avoided, but he nevertheless recommended the use of a damping device such as was offered by the Vulcanhy draulic-mechanical transmission gear.

Dismantling an Old Canal.

The following account of the dismantling of an old canal in the United States is taken from the *Engineering News-Record* :—

On the one hundredth anniversary of the incorporation of the Morris Canal and Banking Co. to build a canal across the State of New Jersey, the canal property is in the process of dismantling preparatory to abandonment. The canal was chartered in 1824 and opened in 1831, but with boats carrying only 25 tons. Its route is from New York Bay at Jersey City, across the Hackensack and Passaic Rivers to Newark, thence north to Paterson where it turns west and runs in a south-westerly direction over the highlands between the Passaic and Delaware River valleys to the Delaware River at Phillipsburg, N.J. The canal proved to be a failure financially and was foreclosed in 1844, and thereafter enlarged to a top width of 40ft., a bottom width of 25ft. and a depth of 5ft., the boats then carrying about 70 tons of freight. From that time it slowly increased its business, and for a short time during the Civil War period and up to 1870, it did a fairly profitable business. About 1870 it was leased by the Lehigh Valley Railroad, but thereafter its business steadily declined, owing mainly to diversion of its traffic to competing railroads.

During the past thirty years or more, repeated attempts have been made to procure legislation permitting abandonment of the canal, which was using ninety million gallons daily of the best potable water of the State. This water, particularly that part diverted from the head waters of the Passaic River, is all needed for public water supply.

The Governor's committee found a tentative value for the whole property, not including the water rights, amounting to 2,959,316 dollars. Of this 1,200,000 dollars represented the Little Basin in Jersey City and 1,631,000 dollars for the right of way through Newark. These values, being based upon an appraisal made in 1912, are very conservative for present conditions. In the settlement the Lehigh Valley Railroad Company also paid the State 875,000 dollars.

In order to hold together the rights and franchises, the corporation was continued in existence as the Morris Canal and Banking Co., holding the property in trust for the State, and it is authorised and directed to drain off the canal, to remove highway and road bridges and refill and resurface the roads at highway crossings, to repair and make safe the sluice gates at the lakes and ponds, to raze, remove or put in safe condition all other structures which may obstruct highways, roads, or watercourses through the fall of culverts, aqueducts, &c.

The dismantling and reconstruction work thus provided for is extensive. There are 144 highway and road bridges, which must be removed, the approaches graded down and the roads resurfaced. There are 19 planes, 28 locks, 9 aqueduct bridges, 19 foot and towpath bridges, 45 culverts, 43 spillways with sluice gates and 11 dams over the 90 miles of canal to be dismantled. Estimates for the whole work have not yet been made. Already sixty sheets of plans have been prepared for this reconstruction work. The dam at Lake Hopatcong is to be immediately rebuilt. The other work has been divided into sixteen sectional contracts, which will be let as fast as money is appropriated for the work. The dam at Lake Hopatcong, as well as that at Lake Musconetcong, and the one at Saxton Falls, will require rebuilding. The first two were never provided with spillways. The dam at Lake Hopatcong has been found to be in dangerous condition. All of the dams need extensive repairs. An offhand estimate furnished the board by the consulting engineer, gives the cost of dismantling at not less than 1,200,000 dollars. A difficult matter is the drainage of the canal and the restoration of the natural drainage to the original watercourses.

This water having in many cases been diverted for a century or more, the original watercourses have been encroached upon or have grown up to such an extent that throwing the water back into the original channels is often difficult and in some cases dangerous. At fully one hundred points serious questions arise in this respect.

The latest statistics taken from the new edition of Garcke's "Manual of Electrical Undertakings," recently published, show that the amount of capital invested in all branches of the electrical industry in Great Britain now amounts to more than £682,436,000. Of this amount electricity supply undertakings account for £207,453,000; electric traction, £226,633,000; telegraphs and telephones, £97,949,000; manufacturing, £110,401,000. The increase in capital for the year is approximately 32 million pounds. The average rate of interest paid on capital was 5½ per cent. On electric tramways and trolley omnibuses throughout the country 4,360,844,688 passengers were carried, and over £30,203,000 was paid in fares. London tramways carried 919,435,027 of these passengers, and the London underground railways carried 410,505,659 passengers in addition. The total number of electrical undertakings recorded is 3180 in Great Britain and all parts of the British Empire, and the new volume gives full financial and other particulars of each undertaking.

A New Level Indicator.

A SIMPLE application of an old and well-tried principle has been adopted by the Aster Engineering Company, Limited, of Wembley, in the construction of the level gauges illustrated by the drawings and engravings below.

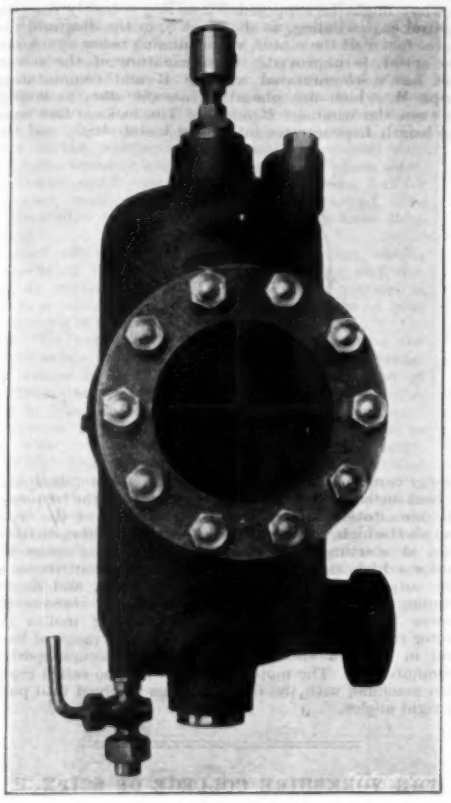


FIG. 1—WATER LEVEL INDICATOR FOR BOILER

Two types of gauge are being made, one for boiler work and the other for showing the level in open tanks, and both possess the great advantage of having no parts in rubbing

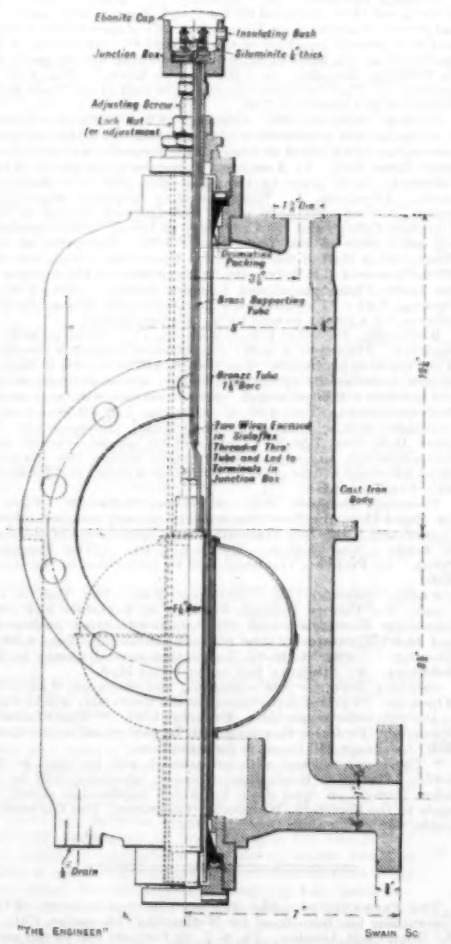


FIG. 2—WATER LEVEL INDICATOR FOR BOILER

contact, so that the delicacy of their indications is unaffected by the pressure to which they are subjected.

Taking the boiler level indicator—shown in Figs. 1 and 2—first, it will be seen that it comprises a chamber which is connected with the steam and water spaces of the boiler in the usual manner. Running up the centre of this chamber there is a bronze tube, which is made tight with ordinary gauge glass packings. The tube is held in place by a cap, and its lower end is open to the atmosphere. At the top sufficient accommodation is allowed for expansion and contraction caused by changes of temperature. Inside this tube there is suspended an electrical choking coil, the connections for which are brought out at the top. The exact level of the coil can be set by an adjusting screw at the upper end and a passage-way is left right through the support, so that a current of air can circulate round the coil. The coil is supplied with alternating current, and requires only some 10 watts to energise it.

Outside the bronze tube there is a stout copper sleeve, round which there is built a spherical float. Precautions are taken to ensure that the pressure inside the float is balanced against the steam pressure on the outside, and as a consequence there is no tendency for leakage, and the float retains its buoyancy. The copper sleeve is a free fit

FIG. 3—INDICATOR

on the bronze tube, so that there is little or no friction as it rises and falls with the water level.

It will be readily appreciated that as the copper sleeve rises, and unmasks the coil, the choking effect on the current of the coil will be varied, and it only remains to connect a voltmeter in the circuit to get an indication of the movement of the float. The voltmeter or indicator—see Fig. 3—is, of course, calibrated and marked to read levels directly. The scale is not exactly symmetrical from end to end, but the variation is only slight, and it is naturally so chosen that the open part of the scale comes at the usual working level. The length of the scale can, of course, be anything, within reason, as it only depends on the construction of the voltmeter. A recording mechanism can be added if it is wished to get a continuous graph of the levels.

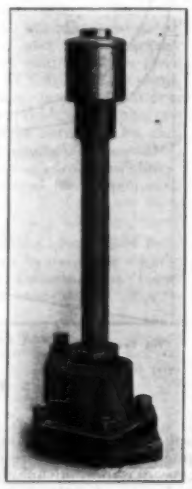


FIG. 4

The same broad principle is adopted in the tank level indicator or manometer—shown in Figs. 4 and 5—but in order to reduce the length of choke coil which would otherwise be necessary to accommodate the variations in level common in tanks, a reducing device in the form of a mercury cup is adopted.

On reference to Fig. 5 it will be seen that the base of the instrument is formed by a cast iron chamber filled with mercury. The upper part of this chamber is connected with the bottom of the tank, either by means of piping or by simply immersing the whole instrument in the tank. The choking coil is mounted in the top of a steel tube fixed in the casting, and surrounding the coil there is a solid-drawn copper tube, closed at the bottom end and floating in the mercury. The outside of the copper tube is coated with a material resistant to mercury, so that there is no liability for amalgamation, which would naturally interfere with the action of the apparatus, to take place. A similar form of indicator is used with the tank gauges as with the boiler gauges. The instrument shown in Fig. 5 is intended for installation in connection with a tank 15ft. deep.

One of the great advantages of these gauges, as compared with a float within the tank itself, is that they show directly the weight of liquid in the tank, and not merely the height. In fact, they measure the hydrostatic pressure at the bottom of the tank, and the readings are unaffected by changes of specific gravity caused by variation of temperature. For this reason the gauges are specially convenient for such services as oil fuel tanks, where the contents are always measured in tons, and where, if a dipping stick is used to find the level of the oil, a correction must be made for temperature. The elaborate ullage tables used by the marine engineer on account of the irregular shape of his

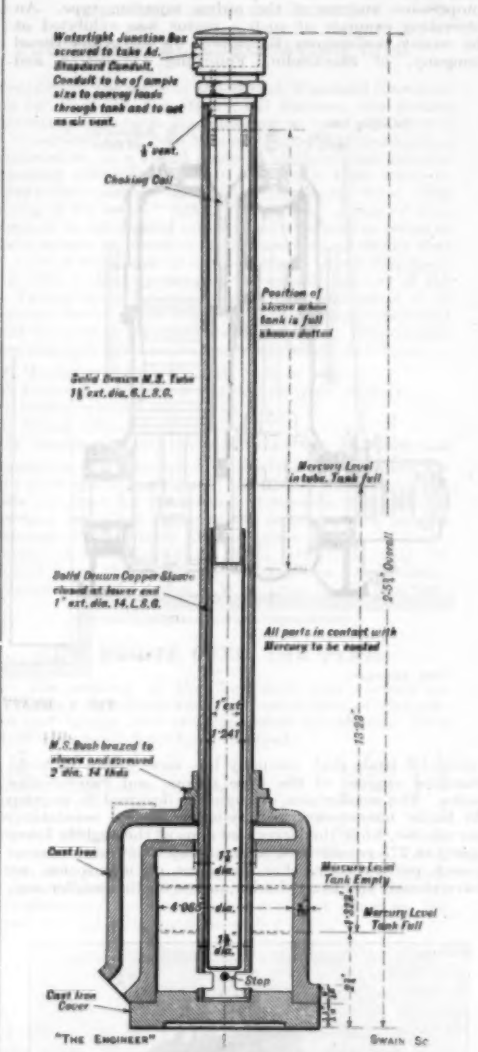

Watertight Junction Box screwed to take Ad. Standard Conduit. Conduit to be of ample size to convey leads through tank and to act as air vent.
¼" vent.
Choking Coil
Position of sleeve when tank is full shown dotted
Solid Drawn M.S. Tube 1½" ext. dia. S.L.S.G.
Mercury Level in tube. Tank full
Solid Drawn Copper Sleeve closed at lower end 1" ext. dia. 14 L.S.G.
All parts in contact with Mercury to be coated
M.S. Bush brazed to sleeve and screwed 2" dia. 14 thds
Cast Iron
Mercury Level Tank Empty
Mercury Level Tank Full
Stop
Cast Iron Cover
"THE ENGINEER"
SWAIN Sc

FIG. 5—WATER LEVEL INDICATOR FOR TANKS

tanks are also unnecessary, as the indicator can be calibrated, so as to take into account any change of that nature.

HYDRO-ELECTRIC PLANT IN SOUTH AFRICA.

AT Noordkaap, near Barberton, in the Transvaal Province, there has recently been put into commission the largest purely hydro-electric plant in the Union. This plant supplies electric power to the well-known Maid-of-de-Kaap Mine. The capacity is 500 kilovolt-ampères, generated on a direct-coupled water turbine alternator set, with a speed of 600 revolutions per minute, under a 56ft. head of water. The quantity of water required is 6000 cubic feet per minute. The pipe line is 96ft. long, 48in. in diameter, and of steel riveted. The turbine is of the twin-runner inward flow reaction type with a horizontal shaft. It is controlled by a pendulum type oil relay governor belt driven from the turbine shaft, and the set is fitted with a fly-wheel approximately 5ft. in diameter. The fall from the intake to the turbine is 44ft., and the suction tube is 13ft. 6in. long. The alternator develops 500 kilovolt-ampères, at 3450 volts, and feeds the transmission line through the generator control panels. The transmission line is approximately 3½ miles long, leading from the power station to the mine. The transformer at the mine lowers the pressure to 500 volts for supplying the three-phase motors. An interesting feature of the transmission poles is that they are made of steel on account of the fire danger, as they pass through country in which there is a lot of long grass. The receiving voltage at the end of the transmission line is 3300. The total number of motors at the mine is 16, aggregating 300 horse-power; and, in addition, there is lighting on the property. The turbine was made by James Gordon and Co., Limited, Kingsway, London, and the electric plant, &c., by the Swedish General Electric Company.

AN advantage the Metropolitan District Railway apparently enjoys with the new rolling stock it is now putting into service is that it can be mixed with older carriages. We have never seen one of the cars of the heavy type introduced some four or five years ago, except in a complete train of its own class, which suggests that the new stock of to-day is of a more uniform weight, and so calls for no restriction as to its use.

The Polar Heavy Oil Engine.

Engineers, both at home and abroad, have devoted considerable attention to the problem of the small heavy oil engine, and some of the most recent advances in this direction have undoubtedly been made in the high-compression engines of the airless injection type. An interesting example of such a motor was exhibited at the recent Gothenburg Exhibition by the Atlas Diesel Company, of Stockholm. Following exhaustive and successful trials that company has now begun to build standard engines of the type in one and two-cylinder units. The smaller size of engine is designed to develop 35 brake horse-power per cylinder at 300 revolutions per minute, while the larger size aims at the slightly lower speed of 275 revolutions, and is rated at 50 brake horse-power per cylinder. For purposes of description we have chosen the two-cylinder engine of the smaller size,

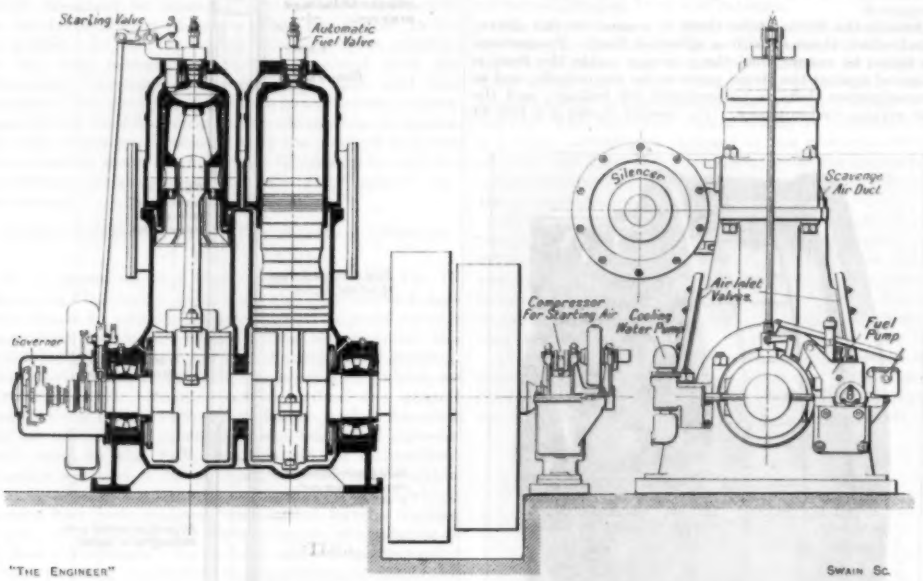


FIG. 1—HEAVY OIL ENGINE

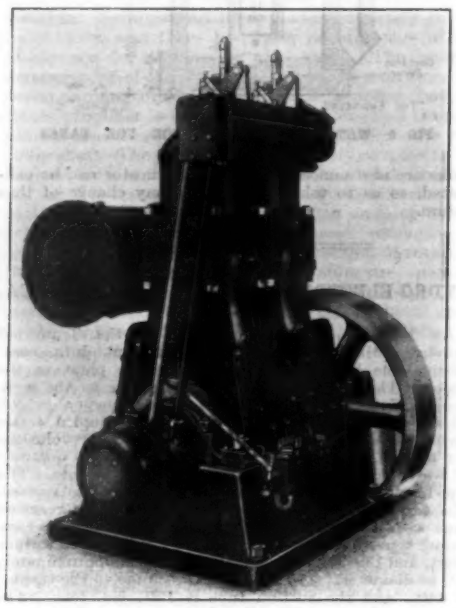


FIG. 2—35 B.H.P. HEAVY OIL ENGINE

which is illustrated in the drawing and engraving reproduced in Figs. 1 and 2 respectively.

The following are the leading particulars and dimensions of this engine :—

Full load output	70 brake horse-power
Cylinder bore	250 mm.
Stroke	350 mm.
Normal speed	300 revolutions per min.
Fuel consumption at full and three-quarter load	0.41 lb. per B.H.P. hour
Lubricating oil consumption	0.003 lb. per B.H.P. hour
Length over outboard bearing	2.85 m.
Breadth over fly-wheel ..	1.20 m.
Approximate overall height ..	1.50 m.
Weight, including fly-wheel ..	4.5 tons approximate

The engine runs on the two-stroke cycle, and crank chamber compression is employed. Mechanical fuel injection is used, and the cylinder pressure is not very different from that used in the ordinary Diesel engine. One of the chief features of the design is the use of a stepped piston, the lower part of which is guided in the upper part of the crank casing. The increased volume swept by the lower piston contributes to the efficiency of the scavenging process. The air which is compressed in the crank chamber reaches the main cylinder through a duct connecting with the scavenge air ports at the front of the engine. Referring to Fig. 1, it will be noted that the piston crown is dished, and it forms with the domed cylinder cover a combustion space of elliptical section. The automatic pressure operated fuel valve, with a single hole flame plate, is placed in the centre of the cylinder cover, and the cylinder is provided with an air-starting valve, operated by a push rod from a cam on the main crank shaft with a hand release.

Both the main liner and the cylinder jacket are cast in one piece with the cylinder cover, and this casting is secured by four bolts to a heavy flange on the top of the crank casing. This part of the engine is robustly constructed, and forms the guide for the lower part of the stepped piston. It is furnished with large inspection doors, to which disc type air inlet valves are attached. The bed-plate is neatly designed, and it is furnished with main crank shaft bearings of the self-aligning roller type.

In the illustration—Fig. 2—the fuel pump is shown on the top of the engine at cylinder cover level, but in the latest designs—as illustrated by Fig. 1—it is placed at the end of the bed-plate immediately outside the end bearing. Alongside the fuel pump is placed a link driven mechanical lubricator, while on the opposite side of the bed-plate is the pump for the cylinder cooling water. The outboard bearing is fitted with a large diameter ball race, and on the end of the crank shaft there is a spur gear for driving the starting air compressor. As shown in Fig. 1 this compressor is placed at the end of the crank shaft, and provision is made for driving it by hand, if in case of emergency the supply of air in the starting vessel should fail. Indicator cards taken from the engine show a marked resemblance to the ordinary Diesel engine diagram, although the working pressure in the cylinder is slightly lower. The fuel consumption is remarkably good, and it is, we are informed, substantially the same at the full load and three-quarters load, while there is little falling off when the power is reduced to half load. In Fig. 3 we reproduce typical diagrams taken under full load conditions from the main cylinder and the crank case. The cylinder compression pressure is about 425 lb. per square inch, while combustion takes place at a maximum pressure of about 540 lb. per square inch. The pressure of the scavenging air is a little under 5 lb. per square inch, this comparatively high pressure being attained by the use of the stepped piston.

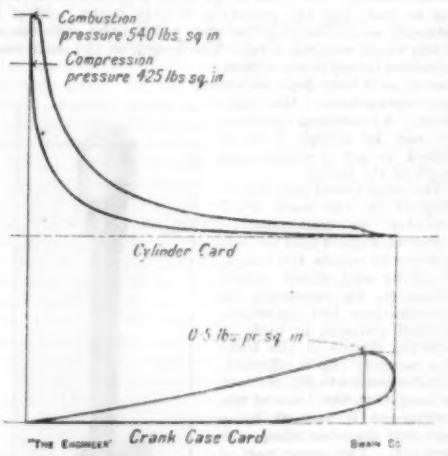
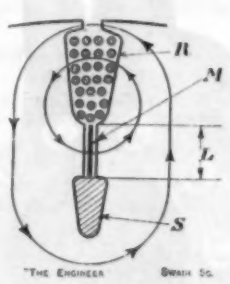


FIG. 3—TYPICAL CARD

The Polar heavy oil engine has certainly many interesting points which should fit it for use, both for stationary work and marine auxiliary service. The London office of the Atlas Diesel Company, Limited, is at 35, Surrey-street, Strand.

A New Single-phase Motor.

In the July issue of the *Journal* of the American Institute of Electrical Engineers, Mr. S. Bergman describes a new type of single-phase motor, which during starting and accelerating possesses the characteristics of a series motor, but after full speed has been reached, behaves like a shunt motor. The author shows that, contrary to what might be supposed, by adding a highly reactive squirrel cage winding, as shown at S, in the diagram, the power factor of the motor, when running below synchronous speed is improved. The armature of the motor also has a commutated winding R and commutating strips M, which are placed in narrow slots extending between the windings R and S. The leakage flux over the length L penetrates into these metal strips, and the



energy corresponding to this flux is, therefore, dissipated in heat instead of sparks at the brushes. As the frequency of commutation is very high the resistance of the strips can also be high, so as not to interfere with the flux distribution at starting. The commutated winding gives the motor a high starting torque, and it also contributes to the output when the machine is at work, and as the winding is connected to a commutator, it corrects the power factor. The squirrel cage winding makes the motor run at constant speed over the rated range of load, and in combination with the strips M secures perfect commutation. The motor is classed as a so-called repulsion machine, with the field windings resolved into parts at right angles.

THE YORKSHIRE COLLEGE OF SCIENCE.

During the week beginning December 15th the jubilee of the Yorkshire College of Science and the coming of age of the University will be celebrated at Leeds. The following programme has been arranged :—

A special service will be held in the Leeds Parish Church on Sunday evening, December 14th, at 6.30. The sermon will be preached by his Grace the Archbishop of York.

Monday, December 15th.—Morning, 11 : Opening ceremony in the Great Hall, attended by the Court, Senate, staff, and past and present students of the University. Short speeches by several past and present members of the University. Afternoon, 3–5 : Reception at the Medical School. An address will be given by Sir Berkeley Moynihan on "Medicine in Leeds." Tea, 4.30–5. Evening, 7 : The University dinner, to be held at the Town Hall. Reception at 7, dinner at 7.30.

Tuesday, December 16th.—Morning, 10.30 : *Official reception of delegates and presentation of congratulatory addresses from universities and learned societies. This ceremony will take place in the Town Hall. 1 : Luncheon to members and guests of the University, to be given by the Right Hon. the Lord Mayor of Leeds. Afternoon, 3 : *Conferment of honorary degrees on certain persons who have given distinguished service to the Yorkshire College and the University of Leeds. This ceremony will take place in the Town Hall. 4.30 : Reception at the Philosophical Hall of the University Court and Senate and the official guests of the University, by invitation of the Council of the Leeds Philosophical and Literary Society. Tea, 4.30–5. Evening, 7.45 : *Presentation of portrait to Sir Michael Sadler, followed by a public lecture by Sir Michael Sadler.

Wednesday, December 17th.—Morning, 11 : Visits to halls of residence. Afternoon, 3–5.30 : Reception of Yorkshire members of the teaching profession. The visitors will be invited to inspect certain departments of the University, where demonstrations and exhibits will be arranged. A short address will be given by Professor Grant. Tea, 4.30–5. Evening, 7.30–10.30 : A conversazione will be held at the University. Reception in the Great Hall from 7.30–8. There will be special exhibits and demonstrations in several departments during the evening. Short addresses will be given by Professor Kendall and Professor Hamilton Thompson.

Thursday, December 18th.—Afternoon, 2.30–5.30 : Visit of the Right Hon. the Lord Mayor of Leeds and members of the Council and Education Committee and Magistrates of the City of Leeds. Tea, 4.30–5. Evening, 7.30 : "The Students' Opera," by Professor Garstang, will be performed in the Great Hall.

Friday, December 19th.—Afternoon, 2.30–5.30 : Visit of the County and County Borough Councils of Yorkshire and their Education Committees and other local education authorities and the Magistrates of the Skyrack Division. Tea, 4.30–5. Evening, 7 : Old Students' Association annual dinner in the Refectory. 8 : Students' ball in the Great Hall.

Saturday, December 20th.—Morning and afternoon, 9.30–5.30 : *Open day. Various departments of the University will be open to the public for inspection. Evening, 7.30 : *"The Students' Opera," by Professor Garstang, will be performed in the Great Hall. A charge will be made for admission.

* The items marked with an asterisk will be open to the public. Owing to limitations of space, admission will be by ticket (except on open day), for which application should be made to the Secretary, Hospitality Committee, The University, Leeds, not earlier than December 1st.

The Ferrantians.—The date for the next re-union of Old Ferrantians has been fixed for Wednesday, December 17th, at the Hotel Cecil, London. Dr. S. Z. de Ferranti will be the guest of the evening and the chair will be taken by Mr. H. W. Kolle. It was originally announced that Mr. C. H. Wordingham would preside, but owing to illness that will unfortunately not be possible. We understand that there has been a considerable response from Ferrantians in all parts of the country, but the hon. secretary, Mr. W. E. Warrilow, 40, Mildred-avenue, Watford, would still like to hear from a number of Ferranti men whose attendance would be greatly welcome.

Wireless Transmitting Apparatus.

ON Wednesday, December 3rd, a paper was read by Mr. G. Shearing, before the Wireless Section of the Institution of Electrical Engineers, on "Wireless Telegraph Valve Transmitters Employing Rectified Alternating Current." The author dealt with some of the valve transmitters and power supply circuits which have been developed in the Experimental Department of H.M. Signal School for Naval purposes. Early experimental work, which is briefly reviewed, indicated that the valve transmitter would supersede the arc and spark transmitters for naval use, and this conclusion has since been confirmed by the results obtained in experimental and routine working with valve transmitters installed during and since 1919 in the Fleet and Admiralty shore stations. The majority of the continuous wave and interrupted continuous wave transmitters use rectified single-phase alternating-current employing two-wave rectification, but for high powers, multiphase rectification is employed. The paper illustrates the principal circuits that have been employed.

Increased efficiency, the author points out, results from operating the valves, both transmitting and rectifying, at maximum anode voltage. This voltage is limited to a value above which there is a danger of blue glow occurring in the valves.

During the period 1918–19 in the naval service the maximum anode supply voltage for average glass transmitting valves in parallel, for an anode dissipation of 500 to 800 watts per valve, was from 7000 to 8000 volts. In order to obtain increased power at these lower voltages it was necessary to employ a large number of valves in parallel with rectifiers designed for low internal resistance and high filament emission. Whilst the experimental design of larger valves suitable for higher voltages was being pushed forward it was obvious that considerable time would elapse before such valves would be available in quantities, and another factor for consideration was the existing high-tension transformer plant which in many cases gave normally secondary voltages to earth of from 15,000 to 20,000 volts.

Experimental trials of valves in series were made during 1919—as shown in Fig. 1—the filament system of the upper valve being at a high-frequency potential to earth. With this arrangement it was found possible to operate at a supply voltage approximately twice the safe value for a single valve, with the valve anodes working at normal full power dissipation. The normal advantage of the series system as regards efficiency is obtained when the anode supply voltage is greater than that which can be applied with safety to a single valve. Another advantage is the reduction in the rectified current for a given rectified power, with resulting increase of rectifier efficiency.

The arrangement has proved to be very stable in operation, and no direct short circuit to earth is caused in the event of failure of one valve, as is the case with valves in parallel. In the case of valves with open grids the insulated grids of the upper valves prevent excessive valve current if, for any reason, failure of the aerial oscillatory current occurs. A typical circuit diagram for a complete transmitting set is given in the paper.

The filaments for the upper bank of valves are supplied from an oil insulated transformer which can readily be designed for high-frequency voltages between primary and secondary windings and small capacity between the windings. The grid coupling coil for the upper bank of valves has to be insulated from its aerial circuit coupling coil for the high-frequency voltage across the lower bank of valves. Separate filament rheostatic control enables equal division of the voltage to be obtained across the valves.

A number of sets of this type was designed early in 1920 for use with transformer plant already installed, and one set employing six silica valves—three valves in each bank with two banks in series—has been in use at Horsea for routine and experimental work since May, 1920.

The small space available in ships for the transmitter has necessitated the employment of plain aerial circuits for normal full power transmissions. Provision has been made, however, for the introduction of a circuit for drying out if for any reason the aerial insulation is liable to be impaired by salt water or spray. For short wave lengths below 600 m. there is usually no difficulty in starting up under wet conditions. A coupled circuit is usually employed, however, on these shorter wave lengths to obtain the necessary constancy of wave length for the highly selective valve transmissions. In many cases use has been made of a resistance-coupled circuit, but alternatively the more usual electro-magnetic coupling has been employed. To enable the change from the plain to the coupled circuit on the same wave length to be made rapidly when required special switching arrangements, which are described in the paper, are employed.

Circuits employing separate grid excitation have been developed experimentally for use with medium power and high-power valve transmitters. It has been usual to connect the grids of the main transmitting valves directly to the local oscillator—as shown in Fig. 2. For the best results with varying power it is desirable to arrange for proportionality between the grid exciting current and the main supply anode voltage, when the grid voltage has once been adjusted to give the best efficiency for a given anode voltage. A rectified alternating-current supply for continuous wave transmission can be arranged for by supplying the exciter from a small transformer, the primary of which is connected in parallel with the main transformer.

Comparative experiments have usually shown that this circuit gives a higher efficiency than the retroactive circuit, provided the grid exciting voltage is properly adjusted. The circuit has been found to be stable in operation, and it is slightly more effective than the retroactive circuit for starting up aerial oscillatory current when the aerial insulation is partially short-circuited by moisture. The superiority of this circuit as regards constancy of wave length is shown in the paper by curves which were obtained experimentally.

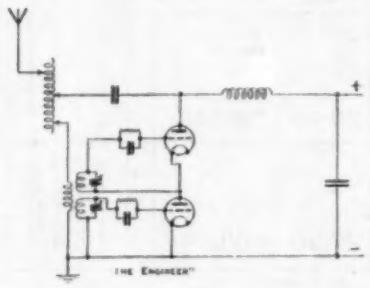


FIG. 1

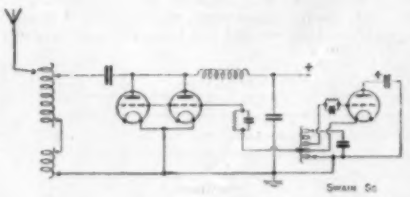


FIG. 2

Australian Engineering Notes.

A MESSAGE from Sydney (N.S.W.) states that the Sutherland Council has accepted the tender of Sir W. G. Armstrong, Whitworth and Co. of £80,320 to provide steel work for the proposed bridge over the George River at Tom Ugly's Point.

* * * * * *

IN the Queensland Parliament it has been announced that the Government intends to construct wharves along the Hamilton wall on the Brisbane River. This is believed to mean that the scheme submitted by Mr. E. A. Cullen, State Engineer for Harbours and Rivers, to the Queensland Government in 1910, will be proceeded with at an early date. The scheme proposed to utilise the area behind the Hamilton wall, thus obtaining a shipping basin for the largest types of vessels with 12,000 lineal feet of quays, and a further 5800ft. along the wall in the river proper. There are no serious engineering difficulties in the way, and apart from the dredging necessary, only as much of the accommodation as may be required need be provided at any one time—in other words, the expenditure would be spread over a considerable period. The estimate of the cost of the scheme was given by Mr. Cullen in 1910 as £830,000.

* * * * * *

ACCORDING to a message from Melbourne, a proposal is being considered by the Federal and South Australian Ministers to construct a southern extension of the Great Western Railway line from Port Augusta (South Australia) to Red Hill, a distance of 84 miles south-east of Port Augusta. For the purpose of discussing the proposed agreement with the South Australian representatives, the Federal Minister for Home and Territories has traversed the route in company with the South Australian Ministers and the Commonwealth Railway Commissioner. The new line, when constructed, will be of the standard gauge of 4ft. 8½in. and will bring Melbourne and Perth several hours nearer to each other. Another result will be that the journey to the west from Albury (N.S.W.) will be completed with only two changes of gauge, one at Salisbury (S.A.) and the other at Kalgoorlie (W.A.). A change between Salisbury and Red Hill will be obviated by the provision of a third rail, which will enable standard-gauge rolling stock to travel right through from Salisbury to Kalgoorlie. Pending the completion of the agreement, no estimate of cost is available.

* * * * * *

THE Marconi Company's tender for the erection of two stations in Australia under the beam system, for direct communication with England and Canada, has been accepted. The station will have a capacity of 86,400 words daily.

* * * * * *

A CABLE message from Melbourne states that the Legislative Assembly, on December 2nd, voted £1,686,000 for a large water supply scheme.

* * * * * *

IN the annual report of the Tasmanian Hydro-electric Department, it is stated that there are prospects of a large factory for the manufacture of wood pulp and paper being established on the north-west coast. The industry will probably involve a capital expenditure of approximately £3,000,000. At first about 4000 electrical horse-power would be required, and present indications are that a further 1000 horse-power would be utilised within a year or two.

* * * * * *

THE following tenders, closing on the dates mentioned, have been invited:—State Electricity Commission of Victoria: Supply and delivery of 22,000-volt transformers and spares, February 2nd. New South Wales Government Railways, Sydney: Supply of two lighting storage batteries, February 11th. New South Wales Government Railways: Supply and erection of two motor-driven air compressors, February 4th. Municipal Council of Sydney, New South Wales: Supply of high-tension oil-circuit breakers, January 27th. Commonwealth Postmaster-General's Department, Melbourne: Automatic telephone switchboards and associated apparatus, April 21st; supply of condensers, January 20th; supply of generators, switches and resistances, February 3rd; supply of pedestal and hand sets, February 10th; reactances and telephone parts, February 3rd; supply of switchboard keys and switchboard jacks, February 3rd.

PURE MINERAL LUBRICATING OILS.

FOLLOWING the issue of the British Standard Specifications for Fuel Oils for Heavy Oil Engines, the British Engineering Standards Association has now published a B.S. Classification of Pure Mineral Oils. This classification is intended to be a broad guide to users of pure mineral lubricating oils to enable them to describe their wants in a more precise manner than is now frequently done. The meaning of the terms "light," "medium," "heavy," &c., as applied to lubricating oils is clearly defined in terms of definite ranges of viscosity, thus removing all doubt that may exist in the minds of users of oils as to whether these terms refer to the viscosity or the specific gravity of the oil. Typical specifications for each type and grade of oil are given, but it is not intended that these specifications should be used as purchasing specifications. The classification has been made under four main heads, as follows:—

(*a*) Machinery and engine oils (pale or red).
(*b*) Internal combustion engine oils (pale or red).
(*c*) Steam cylinder oils (dark).
(*d*) Steam cylinder oils (red).

Oils containing fatty oils have not been included.

Extensive notes are given indicating the purposes for which each grade and type of oil is best suited, and full details are given for the testing of the oils, the methods of testing described being those recommended by the Institution of Petroleum Technologists.

Copies of the publication (No. 210–1924) may be obtained from the B.E.S.A., Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

NEW BRIDGE OVER THE TYNE.

AT the meeting of the Newcastle City Council on Wednesday, the tenders for the construction of the proposed new bridge over the Tyne were considered. Five tenders, as follows, have been received:—

	£	s.	d.
Dorman, Long and Co.	571,225	1	8
Cleveland Bridge and Engineering Co.	604,421	2	4
Sir William Arrol and Co.	606,454	2	0
Sir W. G. Armstrong, Whitworth and Co. ..	743,229	5	5
Motherwell Bridge Co.	743,938	9	8

The recommendation that the tender of Dorman, Long and Co., Ltd., should be accepted was unanimously adopted. The same tenders were laid before the Gateshead Council on Wednesday, but the matter does not come up for decision by that body until December 17th.

CATALOGUES.

S. G. LEACH AND CO., Limited, 20-30, Artillery-lane, E.C.—A leaflet on the "Runsyne" illuminated advertising sign.

BARIMAR, Limited, 14-18, Lambs Conduit-street, Theobalds-road, W.C. 1.—A booklet dealing with the Barimar welding repair service.

BELL'S UNITED ASBESTOS COMPANY, Limited, 59½, Southwark-street, S.E. 1.—Brochure, "The Development of the Asbestos Industry, 1871–1924."

FERRANTI LIMITED, Hollinwood, Lancashire.—Pamphlets Tal 52 on "Oil Immersed Static Transformers"; Tal 55 on "Oil-testing Equipment"; Tal 73 on "Externally Operated Oil-immersed Tapping Switches."

ENGLISH ELECTRIC COMPANY, Limited, Queen's House, Kingsway, W.C. 2.—Publications No. 549 on the "English Electric" air valve; No. 555 on closed feed systems and heat balance for central power stations; and revised price list No. 1021.

CONTRACTS.

VICKERS LIMITED, Barrow-in-Furness, have received an order for washing trommels for the Rand.

MERRYWEATHER AND SONS, Limited, of Greenwich-road, London, S.E. 10, have received an order to supply a new fire float for London. The new vessel, which will be 70ft. in length, will be fitted with internal combustion engines of 220 brake horse-power and Merryweather turbine pumps having a capacity of 2000 gallons per minute at a pressure of 90 lb. per square inch.

LOCOMOTIVES FOR EGYPT.—The Inspecting Engineer of the Egyptian and Sudan Governments has notified the Department of Overseas Trade that the Egyptian State Railways are advertising for five passenger engines for the Luxor-Assuan line. The gauge of this line is 3ft. 6in. The Commercial Secretary at Cairo, Mr. E. Homan Mulock, reports that the adjudication for these engines takes place in Egypt on January 13th, 1925, and that the total cost estimated on the last supply price is approximately £E20,000 delivered in Egypt. Specifications can be obtained from the Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W. 1, at the price of 10s. each.

THE OPTICAL SOCIETY.—An extraordinary general meeting of the Optical Society will be held at the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, at 7.30 p.m., on Thursday, December 11th, 1924, for the purpose of considering and, if thought fit, adopting the following resolutions relating to rules regarding student members:—(1) That the existing Rule VI. be replaced by the following:—Rule VI. Student Members.—The class of student members is restricted to (a) persons under twenty-one years of age; (b) persons attending a full-time course of instruction in science at a recognised institution. A student member on ceasing to be qualified as above, if desiring to remain a member of the Society, must apply for transference to the roll of members, and such transference shall be made by the Council without payment of entrance fee. (2) That Rule VIII. be amended by substituting for "£1 1s." in line 12 of said rule "10s. 6d."

Solid Crank Axles.*

By Sir HENRY FOWLER.

On the crank axle which we have adopted on the Midland Division of the L.M.S. we have put a two centre radii on the big end of 2¼in. and 1in. The result is that at the bottom we have only 2in. in width for the flat bearing portion of the pin. Some of my friends and some of my colleagues have told me that solid crank axles are not suitable for engines with cylinders above 20in. in diameter owing to the development of hot big ends. I think I am not giving anything away when I say that out of the 3000 locomotives which I had charge of and still look after, last year the number of hot big ends which caused casualties and therefore caused loss was extremely small, in spite of the fact that 237 of those engines have 20½in. cylinders and the whole of the piston pressure was on the 2in. width of the big end journal. It is quite clear that in the construction of crank axle one must be very careful to remove all sharp corners.

We have found that far and away the worst feature we have to deal with is the keyway, which is cut in order to put on our excentrics. We have taken steps recently to see that the ends of our keys are rounded, and are making our keyway shallower with quite a good radius on the edge, and the edges of our sweeps are also radiused. If we could have done away with keyways altogether we should doubtless have eliminated serious trouble. Table I. shows how the mileage of crank axles on the Midland Division has improved. It shows all the axles taken out of service either owing to defects or to wear. Practically speaking, we have now doubled our mileage and also the life of the crank in years. That we hold is partly due to the method of testing and the way we have dealt with our cranks apart from the question of testing. I want, however, first of all, to speak on the life history of a solid crank axle. Fig. 1 shows the test block as used on the Midland Railway.

It must be noted that the centre of the ingot from which the axle was forged is approximately the centre of our test piece No. 4. That is to say, it is at the position where one is most likely to get serious unsoundness. In Fig. 2 is seen the result of the investigation of the elongation which we got with the No. 4 bar as compared with the mileage obtained. It will be observed that the increase in elongation goes with an increase in mileage. The result shown by the diagram is for twenty years, from 1904 to 1923 inclusive, and we early arrived at figures showing that the life of a crank axle was dependent on the elongation of our No. 4 test bar. Now this test bar which we have taken as our criterion is that, as I have already pointed out, which lies right in the centre of the ingot.

After we had been investigating this question for some time and had correlated the elongation to the life of the crank axle, Mr. Treadgold called attention to the fact that when we found crank axles within the lower range of tensile strength their mileage was exceptionally good, and Fig. 3 shows the crank axles taken out of service during the years 1911 to 1923 inclusive. It will be seen that as we go down in tensile stress we go up in mileage. This was a point on which for a long while we had an interesting controversy with the manufacturers, the suggestion being from some quarters that we did not have a crank axle of a high enough tensile stress. However, our experience showed that with the softest cranks we had the longest life even when wear as well as fractures were taken into account. The reason seems to be summed up in a few words, viz., that the true criterion should not be strength, but toughness, and that a crank should have a high elongation accompanied with a low tensile stress. We continued, however, to look very carefully into the whole subject, and further reviewed the carbon content as found in the crank axles which we had taken out of service, arriving at the conclusion that the majority of crank axles were made from steel containing considerably too much carbon. We are therefore definitely of the opinion that if the makers lower the carbon we shall get a much greater life, as we believe is evidenced by Fig. 4.

This figure gives details of both tensile stress and mileage for the axles taken out of service for one typical year. These are set out in groups of ten, and you will see that the highest group gave a mean tensile stress of 34.76 tons per square inch, whereas the mean mileage is 283,366. The next group has a stress of 33.17 tons per square inch, the mileage being higher. In the middle group the mileage considerably increased. With the next group, giving a mean stress of 29.4 tons, the mileage still slightly increased again, and then finally for the bottom group of ten, the stress of which was below 28 tons per square inch, we get a mileage of 465,264. The curves on the right show graphically that where the tensile stress comes down the life of the crank goes up, and you will notice that there is a mileage increase of 181,898 for the comparatively small drop in tensile stress indicated.

Many years ago, before I came to the "Midland," I carried out some experiments to try to ascertain how much a crank axle "breathed" in running from the weight of the engine coming on the journals, and I found that it was an appreciable amount. The result is that with every revolution of the wheels there is an opening and shutting of the sweeps about the pin in the centre, and although it is small, it must be accentuated when you get the pressure exerted by the steam on the piston through the connecting-rod. If a crank runs a million miles—and we have several at the present day which have run a million miles and are still in good condition—and it is a 5ft. 6in. wheel, it means that it has made over three hundred million revolutions. Now what is the result when you get a certain stress at a point which, you will remember, is about the centre of the ingot and where you are likely to have the largest number of non-metallic enclosures? Well, I think it is quite plain to see why we have been able to correlate the life of our cranks with the elongation obtained from No. 4 test bar. There is, however, another point and one which I am hoping will be investigated through some of the work which is being done in the laboratories in this country and in the States. Let us now consider what occurs in ordinary running. In the first place, the pair of wheels keyed to the crank axle are constantly moving across the rail and up against the tire flange. At times they strike a crossing or a check rail when moving at considerable speed. This blow may come at a point where it will set up a considerable stress on a portion of the crank at which a manufacturing defect due to segregation or a non-metallic enclosure exists. This may result in the start of a very small flaw, which by repeated blows and fatigue may grow.

In Fig. 5 we have an indication of the various positions where factures occur, shown on a percentage basis. The worst position is at the keyway, and owing to the fact that we have so many old cranks it seems rather high. We do, however, get trouble with these keyways and they amount to 31 per cent. of the total. Then the next highest, i.e., 24.6 per cent., is at a position which is, practically speaking, in the centre of the ingot. It will be seen how necessary it is to have a good radius at this point, other-

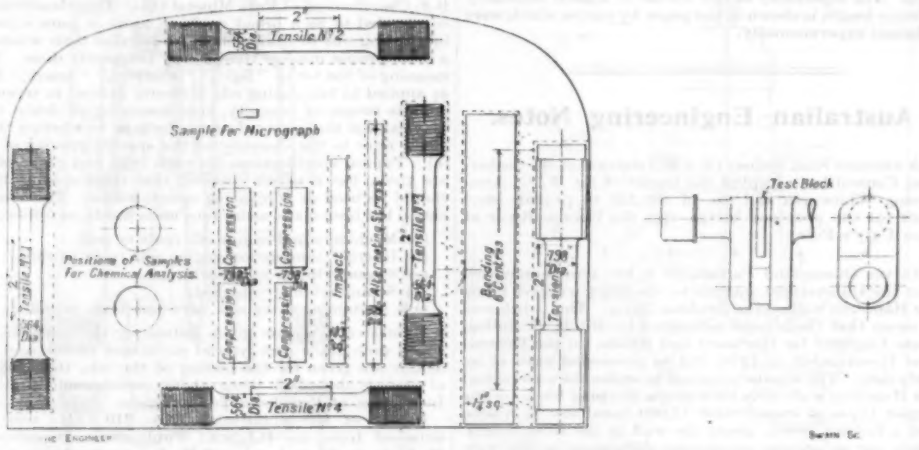


FIG. 1—MIDLAND RAILWAY—CRANK AXLE TEST BLOCK

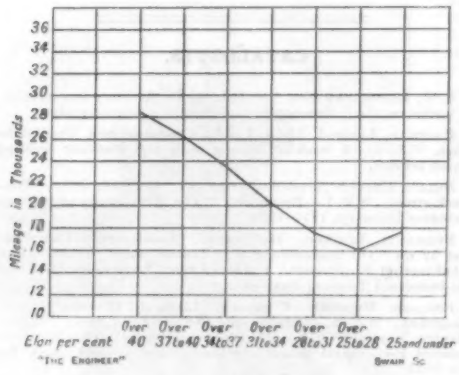


FIG. 2

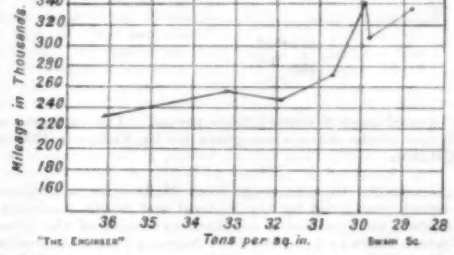


FIG. 3

Tensile Test (Mean of Ten) Tons per sq in	Mileage. Mean of Ten.
34·76	283,366
33·17	295,769
31·21	372,375
29·40	389,331
27·90	465,264

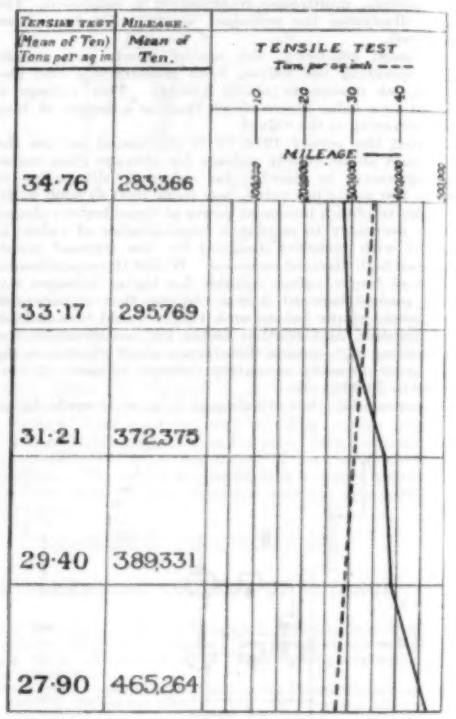
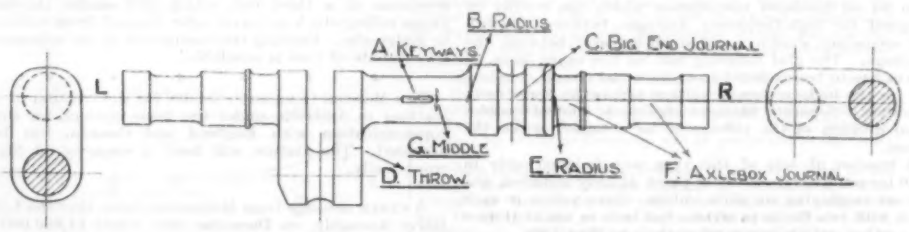


FIG. 4



Position of Fracture	No of Axles	% of Total No of Fractures
A	173	31·0%
B	137	24·6%
C	106	19·0%
D	12	2·2%

Position of Fracture	No of Axles	% of Total No of Fractures
E	48	8·6%
F	74	13·3%
G	8	1·4%

"The Engineer" Swain Sc

FIG. 5—POSITIONS OF FRACTURES IN CRANK SHAFTS

TABLE I.

Crank Axles Taken Out of Service, Years 1905–1923 Inclusive.

Year.	Number of axles.	Average service. Yrs. mths.	Average mileage.
1905	143	9 3	237,721
1906	128	9 3	231,555
1907	144	9 8	248,271
1908	107	10 5	261,774
1909	79	9 10	252,804
1910	93	10 11	282,029
1911	119	10 11	276,201
1912	108	11 10	295,644
1913	119	13 4	318,056
1914	90	12 4	300,480
1915	104	12 1	295,134
1916	95	15 4	372,596
1917	62	16 4	376,672
1918	76	15 5	359,489
1919	80	19 2	445,291
1920	102	18 9	415,937
1921	153	19 5	453,562
1922	119	16 9	368,423
1923	97	21 0	465,473

* From a lecture to the Institution of Locomotive Engineers.

wise the ill effects of a sharp corner result. The diagram is, of course, for a double-framed engine, of which there are still a few in existence; but the defects are shown on a diagram of this type so that the whole position may be seen.

The subject dealt with this evening is but a small one, but he, the lecturer, thought it would be of interest to place his experience before the members.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Little Variation.

THE industrial outlook in the Midlands and Staffordshire continues cheerful. The general improvement is reflected in the reduction of unemployment. The iron and steel trade shows little variation from the last few weeks, but there is a better demand for pig iron, and the general outlook seems rather more favourable. The market remains in a sound condition with firm prices in all departments. The current of demand is not flowing quite so strongly as it was, one reason being that many manufacturers are anxious to keep well within bounds for stocktaking purposes. The New Year is expected to signalise an expansion of trade, which will justify the prudence of those who are buying forward. The announcements which have been made regarding the intentions of the Government as to Imperial Preference and a new Safeguarding of Industries Bill have given great satisfaction.

Manufactured Iron.

The Staffordshire manufactured iron trade continues to show slow though gradual improvement. Good sales have taken place in marked bars, no difficulty being experienced in obtaining the basis rate of £15 per ton. Unmarked bars, of Crown quality, are in rather better demand from the wagon builders, and a fair amount of business is passing at from £12 10s. to £12 15s. A very acceptable change is the continued booking forward of finished iron, a condition of things quite unknown during the last twelve months. The nut and bolt iron market still drags, and buying is done on a restricted basis at about £11 15s. Orders generally lack bulk. With continental material dearer, the outlook in the home manufacture department has a little better appearance. Belgian nut and bolt iron is quoted at £7 12s. 6d. to £7 15s. Some nut and bolt makers are preferring steel and adapting their plants for this somewhat more uniform and rather cheaper material. There is an improved inquiry for galvanised sheets, and prices are firm. Twenty-four gauge corrugateds command £17 10s. to £17 12s. 6d. f.o.b.

Raw Iron.

Midland blast-furnacemen firmly maintain the late advance of prices, and some smelters on 'Change in Birmingham to-day—Thursday—required a special price for deliveries beyond February. Stocks of foundry pig iron are gradually being reduced. Only in a few instances are purchases made at quotations higher than those prevailing last week. Northamptonshire No. 3 foundry is offered at from £3 16s. to £3 17s., and Derbyshire at £4 2s. 6d. at furnaces. The latter district has benefited a little by the rise in Cleveland pig iron prices and improved export business, which is giving Derbyshire iron a better footing in Lancashire markets. So far nothing is said about starting furnaces in this district, but an agreeable change is that some plants find their output exceeding their manufacture with fair reserves of orders. There is not much improvement in the call for forge grades. Northamptonshire makes sell at £3 10s. to £3 12s., and Derbyshire at £3 17s. 6d.

Blast-furnace Coke.

The restarting of idle furnaces in the Midlands depends to a great extent on the price of coke, which is due for revision, but consultations so far between blast-furnacemen and coke makers leave prices for the present unchanged. Midland blast-furnace owners are nervous regarding the effect on coke prices of the trade improvement which has lately developed. The present agreement between the cokeries and the blast-furnacemen by which coke is based on 16s. 9d. per ton at ovens for the lowest grade expires at the end of the year. This places the producer of pig iron in a somewhat awkward position. When he is approached by consumers who want to make sure of their forward supplies of raw material he has to choose between the risk of losing the market and the other danger that when orders are due for fulfilment his production costs may have increased. Some smelters regard acceptance of the business offering as the safer policy. Pig iron has been sold in limited quantities over the first two months of the next year. Other makers, however, hesitate to commit themselves. Present indications are against any such strengthening of the hands of coke suppliers as would enable them to put up the price. Makers of pig iron are pressing for lower prices.

Steel.

In the steel trade a fair aggregate of constructional material is called for, and local engineers are busy tendering for fairly good contracts, particularly in the way of building and works extension. A steady inquiry is reaching the steel works, and order books have changed favourably during the last two or three weeks. General steel requirements are increasing, following the improved tone in several Midland steel-using industries. Output shows general improvement, and works which lately ran for four days a week have been put on full time. The industry is still badly wanting shipbuilding orders, the improvement in that department being so far discouraging. While some big railway orders have been placed in other districts, this class of business is rather scarce in the Midland area. There are fair demands for railway axles and tires. The rolling stock building works take regular supplies from Staffordshire forges and mills, although the amount of work available is quite insufficient to keep these plants in full employment. A recurrence of price cutting in certain classes of steel is not regarded very seriously. Bedstead angles are obtainable at £9 15s. and tube strip is offered at £9 10s. If anything, the stringency in the continental trade is less acute. It is possible to buy Belgian billets for delivery in this district, but they are now at a minimum of £6 15s. per ton, and at least six weeks are required to deliver. Finished steel can be bought rather cheaply at prices which give an advantage on export orders over native steel as well as for delivery in this country. Considerable supplies of foreign steel are coming in against old contracts, so that the withdrawal of quotations by some of the shippers has caused no great apprehension among consumers. The prevailing tightness is generally regarded as a temporary phase. Meanwhile, a few more orders are coming the way of the home producer.

Bright Future for Electricity.

That there is a bright future for the electrical industry was the impression gathered from the various speeches at the annual dinner of the South Midland Centre of the Institution of Electrical Engineers at Birmingham last week. Mr. R. A. Shattock—city electrical engineer, Birmingham—pointed out that the electrical industry in Birmingham had not felt the slump in trade as some others had—in fact, the increased demand it had had to meet this year and last had been phenomenal. It was growing at an increasing rate, and that must mean a greater amount of continuous business for those engaged in the industry. He thought that the outlook so far as they were concerned, was undoubtedly bright. Principal C. Grant Robertson said that it was undeniable that in the last thirty or forty years Birmingham had been a great pioneer in the task of showing what a great city could do by its municipal enterprise on the line of assisting civil development through organised science. Electricity supply was not the least important, and we were only at the beginning of what might be done. Councillor H. K. Beale—chairman of the Electric Supply Committee—intimated that they were not only pushing further and further afield in Birmingham in electrical development, but were looking for fresh directions in which to educate the public in the use of electricity. Immediately after Christmas he was going to ask the City Council for a further £750,000 for developments in Birmingham. Mr. P. J. Pybus said that there was one phase in which development of electricity in this country was far behind that of almost any other; he meant so far as concerned the agricultural and completely rural areas. Whatever improvements might be necessary regarding increased facilities for the large towns and the general electrification of railways, there was no doubt the rural and agricultural areas had been shamefully neglected. Sir John Snell, chief electricity commissioner, spoke of the wasteful use of coal in this country, and said that with the better use of electricity that would be avoided. He suggested that it was part of their duties as members of the industry to assist in bringing about the required improvement.

Midlands Canal Scheme.

It is anticipated that one of the schemes for linking Birmingham with the sea by improved canal communication will be further advanced at the next meeting of the Birmingham Special Canals Committee, at which a communication from the Ministry of Transport will be considered. Some months ago a deputation went to London to ascertain to what extent the Government might be prepared to assist a scheme for the improvement of the Severn waterway. Mr. H. Howard Humphreys, of London, drew up at the end of last year a report on the basis of through passage from Sharpness to Birmingham of 100-ton barges, and this was later supplemented with a report on the basis of 80-ton barges. The estimated cost of the Severn schemes on the basis of the 100-ton barge standard is 2½ millions; and practically the whole would be expended on engineering works on the existing canal between Birmingham and Worcester, on which a long chain of locks is necessary to negotiate the rise of 425ft. between the two cities. The terms of the Ministry's reply are eagerly awaited by industrialists in this district interested in canal navigation.

Birmingham Brassfounders

The Birmingham Brassfounders' Employers' Association held its annual dinner last week, when the opinion was expressed that the industry had now passed through the valley of depression and was beginning to climb the hill of prosperity. Mr. A. Ramsay said that a good many manufacturers had had during the last twelve months very anxious moments. Now they had a respite, and the opportunity should be taken to improve the condition of the country as a whole. Their export trade was 25 per cent. less last year than it was in 1913, taxation per head was £16, as against £7 in France, and £3 in Italy, while industry was taxed to the extent of many millions more than in any other country in the world. What chance had the individual employer to contend with such great forces? The first duty of employers was to get together, unite their forces, unite their understanding, and do what they could, not only to support one another, but to help the well-being of their industry and their people. Mr. B. B. Blackburn spoke of the interesting activity which had been initiated during the past year by the formation of an investigation committee. This committee, he said, had, through judicious deliberation, often forestalled impending trouble.

Activity in the Brass Foundries.

Reports from the Birmingham brass manufacturers vary a good deal according to the branches of trade with which they are concerned. Those who specialise in fancy wares have been very busy in anticipation of the Christmas trade. Cabinet brassfoundry has likewise been in good request. There is a more confident spirit abroad, both in the home and export trade. Little improvement can be perceived, however, in those branches of the industry which are concerned with engineers' and plumbers' brassfoundry. No more business than formerly is coming forward from the shipbuilders. Such broadening of demand as the home trade shows is traceable to the building of villas of a type which calls for more and better brass fittings than are employed in the subsidy class of house. The installation of central heating systems is providing a lot of work for the brass trade.

Ironworkers' Wages.

As the result of the ascertainment under the sliding scale of the Midland Iron and Steel Wages Board, ironworkers' wages are to remain unaltered at 67½ per cent. above the basis rate of 13s. 6d. until February 7th, 1925.

Fewer Workless.

The improvement in trade generally in the Midlands has had an appreciable effect upon the unemployment returns. The absorption into industry of an additional 1131 hands reported last week has been followed this week by the employment of an additional 2408 hands, bringing the total unemployed in the Midlands area down to 140,332, of whom 32 245 are in the Birmingham area.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Trade Prospects in the Engineering Industry.

SUFFICIENT time has not yet elapsed for any startling improvement in the engineering industry since the change of Government, but there is no doubt that what little change there has been is in the right direction. Where there is no material betterment, there are sound hopes of more trade developments. I have made inquiries in many directions as to the prospects, and almost invariably the reports which I have received have been favourable, although business is still far from normal. There are, however, a few really bright spots dotted about in the various branches of the industry. One well-known machine tool firm in this district, for instance, has had a night shift engaged for the past three or four months, and an equally well-known electrical firm is similarly situated. The textile machinery makers, too, are somewhat better off for work, although they complain of the difficulty in obtaining orders in competition with American and continental firms. Locomotive builders are moderately well employed, and internal combustion engine builders claim some slight improvement. Taking things all round, therefore, it would appear almost certain that the present year will end better than 1923, and the outlook for 1925 is much more hopeful than was that of 1924.

Metals.

In the copper market here a good deal of disappointment was felt at the slight setback which occurred after November 19th; but in reality it was only trifling, and cannot be taken as an indication of any change for the worse in the general condition of the market. So many false starts have, however, been made in copper during the last three years that buyers are naturally nervous about any small downward movement, and feel that they might as well postpone any buying, because the time for a steady advance in copper prices has been delayed again. However this may be, there must come a time of revival, and at the present moment general conditions seem favourable for it. There is clearly more buying in copper for the Continent, and if American producers will only be content to refrain from increasing their output, the statistical position will soon be better. Full particulars of the American position have now been published by the Bureau of Metal Statistics, and these show that the apprehension caused by the withholding of publication, although very natural, was not justified. The actual statistical position is not at all bad, and is, in fact, much better than many people imagined it to be. In the Manchester district consumers of refined copper are still acting rather cautiously, and there is too much disposition to buy only such quantities as can be used up at once. It is a change from this spirit of caution to a spirit of optimistic buying which is needed to give a good start to copper prices, and possibly the better trade feeling which always comes in the early part of the year will bring about this change. The dealers in old metals here are still rather sceptical, and seem to be very cautious buyers. They have, of course, been disappointed a good many times, and have been taught caution by experience. The market for tin does not yet rush upwards to the extent predicted by some optimists last month; but it has kept at rather a higher level for some time, and consumers have become accustomed to pay over £260 for small lots of English metal. The chances of higher prices than this do not seem to be particularly bad, especially as the market will soon have no reserve stocks in the East to rely upon. Lead and spelter have both been very firm again. Lead at the present prices certainly suggests danger; but spelter, although it is £2 per ton dearer than in October, is not extravagantly high.

Pig Iron.

The business here in pig iron is rather slow this week, but the feeling in the market remains fairly firm. There does not seem any reason to expect lower prices this month, but as to whether the market will improve in the new year there is considerable difference of opinion. Makers of pig iron and the selling agents here are confident, and do not seem at all anxious to commit themselves very far ahead, partly because no one knows yet what will be the cost of coke next year; but one has to remember that there are very many idle furnaces waiting for a favourable opportunity of starting again, and this suggests that in any case the market cannot make much progress in an upward direction until the demand is large enough to give employment to these furnaces. Con

sumers of foundry iron here are not buying very much, but this was scarcely to be expected, as very many of them are supplied with all the iron needed until the end of January, and some of them up to March. The usual price quoted in Manchester for Derbyshire No. 3 iron is 90s. per ton, and there is now very little iron offered at less, for the Northamptonshire furnaces are not so easy as they were. There is a small demand here for Scotch pig iron, but consumers do not like to pay the price of 107s. 6d. per ton. Some founders, of course, will have Scotch to a certain extent, whatever it may cost, but for ordinary foundry work it is too dear, and the price is certainly restricting the use of the iron in the Lancashire district.

Steel.

There is scarcely any movement yet in the market for manufactured steel, and apparently none is expected. The continental position seems weaker again, and the low prices certainly constitute a serious danger to our markets. There is still far too keen a competition for every order that comes forward, and until there is a much better employment for our steel works, one does not see how prices are to be raised to a good paying basis. The nominal prices this week are £9 to £9 2s. 6d. for joists and angles, £9 15s. to £10 for plates, and £9 15s. to £10 5s. for bar steel.

Scrap.

The falling off in the demand from Sheffield for steel scrap is disappointing. Dealers here were beginning to offer up to 65s. per ton on trucks in Lancashire for heavy melting steel scrap, but some of them have now gone back to the old price of 60s. or at most 62s. 6d. It seems that consumers in Sheffield have refused offers of steel at 75s. delivered; but it does not seem improbable that they will soon have to pay 80s. Cast scrap is quiet and dull, but it is no worse than it was, and perhaps a little better. Dealers here are quoting 85s. for the best lots, but good scrap can still be bought at 80s. In heavy wrought scrap there is no change.

Lancashire's Staple Industry.

Although certain firms engaged in the cotton industry are having a very prosperous time, the trade generally is far from being happily situated. It will be remembered that in October there were complaints that the section spinning American cotton was not producing sufficient yarn to meet the requirements of the weaving section, and it was therefore decided by ballot of the members of the Federation that the working hours of the spinners should be increased from 26½ per week to 32 hours. It was hoped that this lengthening of the working time signalised the commencement of a general improvement in trade, which would continue gradually, but the improvement has apparently not continued as well as it promised, and the suggestion of a further increase in the working hours to 39½ per week which was submitted to the Federation was "turned down" by a large majority. The largest customers of the Lancashire textile industry were China and India, and unfortunately these markets have diminished during recent years for reasons which are outside our control. I understand that the Manchester Chamber of Commerce has sent a memorandum to the Board of Trade with regard to the Anglo-German Commercial Treaty, setting out the difficulties experienced by Lancashire interests in trade with Germany. In this memorandum the existing system of import licences is criticised, and cases are given in which English trade is being hampered. The Chamber of Commerce condemns the present method of levying import licences, which are said to be the chief barrier against the cotton export trade to Germany.

Manchester Association of Engineers.

A paper on hydro-electric schemes, with lantern illustrations, was read at a meeting of the Manchester Association of Engineers by Dr. A. H. Gibson, M. Inst. C.E., on Friday, the 28th ult. He said that there was probably no branch of engineering which offered so large a scope to the imagination, the ingenuity and the common sense of the engineer, and which in itself offered so many interesting problems as hydro-electric engineering. Schemes of this kind of any magnitude required the closest co-operation of the geologist, the hydraulic expert, the civil engineer, the contractor, the mechanical engineer, the electrical engineer and the sales organiser. The author described types of lay-out for high, low and medium head schemes, the use of surge tanks, turbines, Pelton wheels and their speed regulation, efficiencies and pressure turbines. The details of construction, settings, bearings and speed regulation of pressure turbines were dealt with. Dr. Gibson said that the pressure turbine, if well designed and installed in a suitable setting, was capable of giving remarkably high maximum efficiencies, as much as 93 per cent. having been obtained on repeated tests of vertical shaft turbines at Niagara, while 90 per cent. was quite common. In a medium head plant the following typical values were given:—One-quarter load, 72 per cent. efficiency; one-half load, 82 per cent.; three-quarter load, 88 per cent.; seven-eighth load, 90 per cent.; and full load, 88 per cent. The author mentioned one type of medium-head scheme which required somewhat special treatment. This was the scheme in which a relatively long pipe line, having only a small gradient, was used to feed the turbines. Owing to the fact that the head available for accelerating the column of water in the pipe line was only moderate, any sudden demand for water, caused by opening the turbine gates on an increasing load, caused a relatively large drop of pressure at the turbines, and that rendered governing difficult. It was explained that, to reduce this difficulty, a surge tank was fitted at a point as near to the turbines as possible. It consisted of a stand pipe surmounted by an open tank, having a comparatively large surface area, the upper level being only slightly higher than that of the water in the reservoir. Any sudden demand for water was then supplied in part by flow down the stand pipe, and the drop of pressure was greatly reduced. At the same time any rise in pressure caused by suddenly closing the turbine gates was also reduced.

Sulphuric Acid Plant.

A paper on the subject of the plant used in the manufacture of sulphuric acid, H_2SO_4, was read by Mr. C. S. Imison at a meeting of the Liverpool Engineering Society on Wednesday, the 3rd inst. Sulphuric acid is probably the most important of all chemicals, not only because of the large quantities produced in every progressive country in the world, but also because of the widely varied uses of the acid in so many different industries. Mr. Imison said that it was to the chemical industry what iron was to metallurgy. It was essential to many industries, such, for example, as the manufacture of phosphate fertilisers, various acids, the sulphates of ammonia, copper and alumina, dyes, explosives, petroleum refining, storage batteries, galvanising, tin-plate and other chemical and metallurgical processes. After tracing the history of the manufacture of sulphuric acid, the author described the various kinds of plant in use. He said that the present output of sulphuric acid in this country, expressed as chamber acid, was rather more than 1½ million tons per annum from plants which had a capacity of about 2 million tons per annum if working fully. At the date of the signing of the Armistice, the capacity was considerably larger, but much plant, chiefly that erected by the Government, had been stopped. At the conclusion of the late war, the total capacity of the plants operating in the United States of America was nearly 9 million tons per year on the same basis, about 30 per cent. being from contact plants and 70 per cent. from chamber plants. The annual output of this acid for the whole world was round about 17 million tons.

BARROW-IN-FURNESS.

Hematite.

There is a firmer tone in the hematite pig iron trade, brought about to some extent by the more pronounced evidences of confidence. No one expected that trade would improve with a rush, and that the production would be considerably increased, but the fact that certain customers are placing orders for forward delivery is proof that they are feeling more confident. The demand is sufficient to keep going the present furnaces in blast, and to permit the clearance of some of the stocks. The fact that the steel departments are taking more iron helps the situation. Not long ago there was no inclination on the part of buyers to order more than they needed for immediate requirements. Now, with the chance of better business and the possibility of prices stiffening, they are more inclined to place orders, and some deliveries are fixed for well into next year. Other orders of a similar character will, it is expected, come along in due course. The business done in special qualities is not heavy as yet, but this class of iron is likely to be in bigger demand. Continental business is not big, but there is a chance of it developing, although not to any great extent. As regards America, reports of better prospects are conflicting, although there are some inquiries.

Iron Ore.

There is a little better trade in iron ore, and the outlook is not so bleak as it was. As the iron trade improves in the district, so will business in local iron ore show better signs. There is not much going out of the district. Foreign ore is in moderate demand, and the conditions which apply to the local ore trade affect also the business done in Spanish and other sorts.

Steel.

There is nothing new to report in the steel trade. There is no information as to the receipt of further orders. The Barrow rail mills may have sufficient orders in hand and to come to take them into January. At present the Workington rail mills are operating one week a month. The hoop and small section mills at Barrow are well situated for orders, but there is not a great rush of business—just sufficient to keep the mills going comfortably.

Road Traction.

The Barrow Town Council is applying for powers to run omnibuses within its boundary, and also to run omnibuses which will take their power from overhead wires. There are several parts of the town at present which are not served by the trams, and which are certainly in need of a service. The Council's Bill will provide for the running of a regular service of omnibuses in these districts and as the laying of rails, &c., is far too costly a proceeding, it is proposed to adopt the electric omnibus which has been successful in other towns similarly situated.

SHEFFIELD.

(*From our own Correspondent.*)

Heavy Steel Trade.

CONDITIONS have become quieter during the past week in the Sheffield heavy trades, but as this is the period of the year when buying is always at a low point, it is not resulting in any less optimistic feeling with regard to the future. Inquiries for delivery in the New Year are coming through with greater freedom, and as it is now generally recognised that steel prices are down to the bottom figures, it is believed that many orders will be placed which have been delayed because of the uncertainty of the market. The open-hearth furnaces have not reduced production, though this is not being disposed of quite so readily as it was a few weeks ago. There will probably be a fairly lengthy stoppage at Christmas and over the opening of the New Year, after which it is hoped that Sheffield will settle down to a term of increasing prosperity. The rolling mills are finding it difficult, either to keep reasonably well employed or to secure business at figures which will mean a profit. Here, again, the end-of-the-year influence is noticeable. Deliveries are being brought down to a minimum, so as to make stocktaking as easy a matter as possible. Another trade dispute is now in progress in Sheffield, 600 men of the Sheffield Forge and Rolling Mills being affected. In the last three years the company has lost £84,000. An offer has been made to re-engage the men at a slightly lower rate of pay for night work, but this has been refused, and the works are now closed. At the last meeting of the shareholders, the chairman mentioned that they had accepted work at a loss in order to retain their men in employment.

Railway and Motor Car Steel.

Orders from the home railway companies are providing the bulk of the work for the railway departments, and fair quantities of buffers, axles, tires and springs are being produced. The production capacity of the plants, however, is so great that only parts of the works can be utilised. Some Indian and South American orders are in course of execution, but generally the overseas trade is coming through badly. Private wagon owners, also, have now dropped almost completely out of the market, owing to the new and more drastic specification which has recently come into operation. As this adds to the cost, contracts were placed and hurried through under the old specification, and only a few contracts are now being placed. Special steel for the motor trades continues to be ordered on a large scale, and some firms are able to rely on a steady flow of orders from this source.

The Lighter Steel Trades.

Makers of all classes of tools report that the market is showing signs of an improvement, though business is being placed in a rather irregular fashion. Engineering centres, with increasing activity, are making larger calls on Sheffield for supplies of steel parts and tools, but the export market is weak, particularly in connection with countries outside the Empire.

Australian Cruiser Programme.

Sheffield firms are keenly interested in the announcement that the Australian Government has invited tenders in this country for the building of the two cruisers, the orders for which will probably be placed early next year. Sheffield firms have trade interests in many parts of the country, and even if no contracts come direct here, the city should benefit indirectly. Cruisers, however, are not like battleships, and there is not much "weight" about the plates or guns. However, a share in the work for two cruisers will be very acceptable at the present time.

Steel Trade with America.

Mr. J. J. Brodrick, Commercial Counsellor to his Majesty's Embassy at Washington, has been visiting Sheffield for the purpose of giving advice to local firms interested in American trade. He states that present conditions are not particularly attractive from the point of view of Sheffield firms, although there are more opportunities than are generally supposed. He adds that a considerable trade in iron and steel can be built up by British manufacturers, if the American market is watched for the openings that occur from time to time.

New Blast-furnace Completed.

Prices are firm in the iron market, and buying, though on a small scale, is steady and confident. An early revival in the pig iron market is expected. That makers have faith in this, is shown by the fact that the Renishaw Iron Company has just completed a new blast-furnace, having a capacity of 1000 tons of pig per week. The most modern improvements are embodied in this furnace, and production will be rapid and on economical lines. It will be started as soon as the demand for pig iron justifies it.

Cutlery and Plate.

As the majority of buyers insist on delivery of plate and cutlery for the Christmas trade before the beginning of December, most of the seasonal rush in these departments is now over, and it is possible, after a review of the position, to form some idea of the extent of this extra trade. On the whole, it has been disappointing from the point of view of profits. There was a big rush for a time, but it was only short-lived, compared with the seasonal business of the old days, which was spread over a much longer period, and used to continue right up to Christmas. The cheaper lines of electro-plate have been the most popular, only a comparatively small trade being done in the best grades and in silver ware. Ordinary conditions are now more or less in force, and a good trade is still being done in stainless cutlery. Pen and pocket knives are poor selling lines, and are meeting with severe competition from the cheap German product, large quantities of which are in the possession of merchants and retailers. The overseas trade in these lines, which at one time reached large dimensions, is lifeless, former markets now taking well-finished articles of Eastern manufacture.

New Leeds Colliery.

The well-known Beeston seam of coal has been reached by the Garforth Collieries, Limited, at its new colliery at Barnbow, near Leeds. The seam has been found to be 5ft. 8in. in thickness and of excellent quality. The Beeston is one of the highest grades of Yorkshire house coal, and owing to its nearness to Leeds a ready market should be found in that district. It is expected that the pits will be sunk to a greater depth, and other seams of coal opened out. New engine-houses and other buildings have been erected in preparation for the sinking of the second shaft, the work on which will be immediately proceeded with. The first shaft has been sunk to a depth of 260ft. Electricity is being used for lighting, winding, hauling and pumping. Garforth Collieries, Limited, is owned by the Old Silkstone Collieries, Limited, of Dodworth, near Barnsley.

Mining Area Extension.

An application has been acceded to by Mr. Justice Sankey and the Railway and Canal Commission for the extension of coal workings in Yorkshire by Crawshaw and Warburton, Limited, Ridings Colliery, Dewsbury.

Leave under the Mines (Working Facilities and Support) Act, 1923, was sought in order to work the Beeston and Blackbed seams near Earlsheaton, Dewsbury. The amount of coal tapped will be about 55,000 tons.

Proposed New Bridge.

The Board of Trade has received an application from the West Riding County Council in regard to the building of a fixed single-span free bridge across the river Aire, at Carlton, near Selby. The existing swing toll bridge is high and narrow, and only permits the passage of vehicular traffic of a weight of not more than 3 tons. The Board of Trade has issued the usual statutory notice for objections.

Two Sewage Schemes.

Newark's scheme for the improvement of its sanitary conditions, costing £80,000, has been completed. Of this sum about £60,000 has been spent on sewerage and sewage disposal. Chesterfield Corporation, out of thirteen tenders, has accepted that of William Moss and Sons, Loughborough, for £64,000 for the construction of new sewage disposal works at New Whittington.

NORTH OF ENGLAND.

(From our own Correspondent.)

Improving Iron Trade Prospects.

THERE are now signs of a definite recovery in the iron and steel trade of the North of England. There is nothing approaching a boom, or even a return to normal activity, but a bigger volume of business is being done, and for the first time for a long period consumers are displaying a willingness to negotiate forward contracts. There is, in fact, a gradual return of confidence based on the belief that prices are down to bed rock without the constant fear that the market will move against buyers. Little advance, however, has been made as yet in the direction of recovering lost overseas markets. The improvement in business has been almost entirely confined to home sales. Rising costs of production on the Continent are narrowing down the margin, but with the advantages of a depreciated exchange French, Belgian, and German producers can still offer iron at a price far below anything with which Cleveland makers can compete, and consequently they still have a good hold on many markets. Still, the business that is coming forward is on an increasing scale, and it encourages the hope that the course is now set for a gradual return to prosperity. Already there is talk of increasing operations at the steel works and of blowing in more furnaces.

Iron and Steel Exports.

The exports of pig iron, manufactured iron and steel from the Cleveland district during November totalled 92,524 tons, compared with 105,490 tons in October, and 75,122 tons in September. The decline was most marked in pig iron shipments, which fell from 44,877 tons in October to 34,980 tons in November. Coastwise pig iron shipments were on an improved scale, but the foreign shipments fell from 28,334 tons to 16,488 tons, and there have only been two months this year when a smaller quantity of pig iron was shipped abroad. Germany was the largest foreign customer with 4390 tons, whilst Denmark received 3225 tons, Italy 2620 tons, Belgium 1388 tons, and Norway 1250 tons. The foreign shipments of manufactured iron and steel advanced from 41,267 tons to 43,924 tons, but a drop of nearly 6000 tons in the coastwise exports reduced the total, which was 57,544 tons for November, compared with 60,622 tons in October. Shipments to South and East Africa, and also to India, showed a big advance, but a much smaller quantity went to Australia.

Cleveland Pig Iron Market.

Business has been a little quieter this week on the Cleveland pig iron market, but this is not surprising in view of the approach of the annual stocktaking season. Still, a few orders have been placed, and the general situation is regarded as satisfactory, belief in continued steady development towards normal activity being as marked as ever. The home demand is confidently expected to expand, and the outlook in the export trade is brightening. The strength of the American market holds out hopes of further business with the United States. There have been some fairly substantial sales to Denmark, and as the f.o.b. price at Antwerp is now on a par with the price of Cleveland iron f.o.b., there seems at length a chance for local iron to regain a footing in many other continental markets. Prices are unchanged, but scarcely so strong as they were last week. Nominally, however, there is no change in quotations, which are: No. 1, 87s.; No. 3 G.M.B., 82s.; No. 4 foundry, 81s.; and No 4 forge, 80s.

Hematite Pig Iron.

The present production of East Coast hematite pig iron is insufficient to meet current needs, with the result that makers' stocks are being rather substantially drawn upon. The improving statistical situation is materially assisting producers to adopt a firmer attitude, and there is a possibility of one or two idle furnaces being put into blast shortly. Mixed numbers remain steady round 88s. 6d. and No. 1 89s. per ton.

Ironmaking Materials.

Except for an occasional inquiry for an odd cargo the market for foreign ore is lifeless, and the price of best Rubio is purely nominal at 22s. 6d. per ton c.i.f. Tees. Ironmasters are pressing for cheaper coke, but the Durham makers are generally adhering to 25s. per ton as their figure for good medium furnace brands delivered at the works.

Manufactured Iron and Steel.

More encouraging accounts are given of the manufactured iron and steel trade. There is much less purchasing of continental semi-finished steel owing to the firmer attitude of sellers abroad, with the result that manufacturers in this district have benefited to some extent. The fact that continental producers of manufactured iron and steel are also less anxious to enter into contracts has diverted a few orders to this area. Demand for shipbuilding requisites is a little better, a few sales of railway material are reported, constructional steel is more readily disposed of, and heavy contracts for galvanised corrugated sheets have been made. Quotations for one or two descriptions of material show a slight upward tendency, but no actual advances are reported.

The Coal Trade.

The Northern coal trade presents a stronger tone under heavy prompt bookings, and the collieries are well stemmed for December. There is still very little forward buying, as the collieries are holding for higher values than are at present quoted. Best classes of steam coals are very firm, as also are gas coals, and second qualities are receiving some attention. There is a much more hopeful feeling in the market, and everything points to higher values. Operations in Durham gas coals are extensive, some heavy contracts for abroad having been arranged, and prices all tend in favour of holders. The coke trade is quiet, and stocks remain heavy, the demand being very slow and prices easy.

SCOTLAND.

(From our own Correspondent.)

Clyde Shipbuilding.

JUDGED by pre-war standards the output from Clyde shipyards for this year to date would be considered highly satisfactory. The returns are above the average of the past twenty years, and have only been exceeded on five occasions. The war years, however, brought reconstruction and enlargements to the yards, resulting in a far greater output capacity. Consequently, a greater flow of new orders is necessary so as to utilise fully the available berths, and make good the tonnage launched. So far, while contracts have shown some improvement, the number is far short of the necessary complement. The comparatively small number of men employed have, it is reported, worked surprisingly well, but a curtailment of production will, unfortunately, be necessary unless business improves. The tonnage launched during November amounted to sixteen vessels, of 57,111 tons aggregate, while the returns for this year to date amount to 199 vessels, of 516,872 tons aggregate. There were launched seven vessels of 5000 tons or over:—Tongariro, turbine, cargo and passenger, 8565 tons, built for the Federal Steam Navigation Company, Limited, London; Rydal Hall, cargo, 7000 tons, for the Ellerman Lines, Limited, Liverpool; Polydurus, turbine, 6300 tons, for Alfred Holt and Co., Liverpool; Princess Marguerite, turbine, 6000 tons, for the C.P.R.; Urla, cargo, 5917 tons, for the Bowring Steamship Company, Limited, London; Lawbeath, cargo, 5500 tons, for British owners; and the Oakworth, motor ship, 5000 tons, for the Dalgleish Steam Shipping Company, Limited, Newcastle-on-Tyne. New contracts include a cargo steamer of 5800 tons, for Glasgow owners, and two ferry steamers for the St. Lawrence, to be built by Napier and Miller; a cargo steamer of 9000 tons, by Connel and Co.; and a high-speed turbine steamer, for the Southern Railway, to be built by Messrs. Denny. Messrs. Ferguson, Port-Glasgow, are to build a twin-screw dredger for the Mersey Docks and Harbour Board, while a number of small tugs and barges will be constructed on the lower reaches.

Pig Iron Improving.

A more hopeful feeling pervades the pig iron market, and though the increase in business is still very limited, the movement reported promises to continue. Home consumers have been more ready to cover requirements a little way ahead, and the export department has had a little more inquiry. Stocks have accumulated to some extent, and makers have not increased prices so far, although the margin of profit is slight in view of oncost charges.

Finished Steel and Iron.

The position with regard to steel sheets and sections is slow to change, and business continues scarce. Some movement has been reported, but not sufficient to reduce to any extent the amount of idle plant. Light and galvanised sheets are very busy, and some makers report that outputs have topped pre-war standards. Demands continue to improve, and orders have been booked as far ahead as the month of March. Heavy gauges improve slowly. Bar iron has a poor outlet. Local demands from wagon builders and engineers are fair, but shipyard orders are far from satisfactory. Keen continental competition is met with, and this applies also to re-rolled steel. Scrap material is in better demand for immediate delivery.

Coal.

With the exception of a few instances, the demand for Scotch coal has not increased, and trade is dull in the extreme. During the past week or so best Lanarkshire splints have sold well for shipment to Italy and the River Plate, the price advancing sharply to about 24s. per ton. Supplies of this fuel are now almost unobtainable until after the end of this month. Steams in Lanarkshire are steadier at 17s. per ton. Single nuts and pearls are selling comparatively well in all districts. Fifeshire and Lothians steams are dull, foreign buyers being indisposed to purchase ahead at colliery prices, while prompt orders are extremely meagre. Aggregate shipments for the week amounted to 263,898 tons, against 246,972 tons in the preceding week, and 287,958 tons in the same week last year. Supplies for the home market are plentiful, and easily obtainable for all purposes.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THERE has not been a great deal of alteration in the state of the steam coal trade since I wrote a week ago, but it is satisfactory that the improvement which developed recently has been maintained and the bulk of the collieries, especially those producing the better classes of coals, are well booked for the remainder of this month. Most exporters will be anxious to get their December shipments away earlier than usual in view of the fact that the Christmas holidays will mean the loss of a full three days' output. The official holidays in the coalfield will be the last three days of Chrismas week, and as there are only three working days in this month after the holidays, it will be necessary for shippers to do their utmost to effect shipments earlier. There has been a rather better inquiry for small parcels, and there are some grades which cannot be picked up at all for this month's shipment. At the same time there is not much forward activity. The outlook for next year is very doubtful, which makes many exporters hold off from operating. It is, however, reported that about 300,000 tons of ordinary Admiralty large coals have been sold for delivery over next year at 25s. 3d. per ton, but apart from this there has been practically nothing done in contracting. There are, however, other orders pending, such as French State Railway business for supply over the first half of the year, and there is the Algerian State Railways inquiry for about 55,000 tons of patent fuel, while tenders had to be in at Cairo on Wednesday of this week for 200,000 metric tons of large coals for shipment over the first five months of 1925. Although no news has been received respecting the allocation of quantities, it is reported on the market that the lowest tenders sent in range from 34s. 8d. to 35s. per metric ton net c.i.f. Alexandria.

Coalfield Items.

The Conciliation Board for this district had a meeting in the early part of this week when one or two questions of some importance were considered. One of these related to a matter in dispute between the joint accountants affecting deferred repairs, so far as the joint audit is concerned, the point being whether it should be referred to the independent chairman of the South Wales District Board or to the independent chairman of the National Board. The owners' accountants desired the latter and the workmen's accountants contended for the former. In view of the difference of opinion the owners' representatives stated that it would be necessary under the terms of the national agreement for the matter to be referred to the National Board. Another subject related to the question of a scale of wages being fixed for boys employed in the anthracite collieries, the Joint Disputes Committee having failed to agree. Trouble has been threatening in the anthracite area on this subject, as the miners desired to tender notices to terminate contracts unless the matter was settled. When the question came before the Conciliation Board the answer of the chairman of the owners' side was that the matter was one which must be dealt with at individual collieries, as there was no procedure for dealing in a general way with matters affecting the whole of the collieries in a particular district. The owners' representatives agreed, however, to the appointment of two representatives to investigate cases at individual collieries, provided such cases were referred to the Disputes Committee in the ordinary way.

Double Shift Working.

The workmen at the Mardy Colliery, Rhymney, received notices to terminate their contracts, but the only way of enabling this colliery to keep going was by the adoption of the double shift working. The workmen having agreed to this, the effect is that a thousand men have been saved from the ranks of the unemployed.

Coal Trimming Conference.

There is to be a conference of representatives of South Wales coal trimmers and the employers concerned at Cardiff on the 9th inst. to consider an application by the men for extra pay for trimming duff coal. The trimming of this class of coal is at the present time paid for at the same rate as other descriptions of coal, but the men desire an increased rate in consequence of the trouble of working it, and the longer time occupied, involving loss of earning power. A short time ago the men at Newport struck work against working this class of coal, but they were advised to resume work on the understanding that a conference would be called to consider the matter.

Miners' Wages.

The result of the joint audit of the accounts for the month of October certifies only a percentage of 15.55 per cent., compared with 17.6 per cent. in September. This is the lowest rate certified under the present agreement. The minimum payable by the coalowners for the current month is 42.22 per cent. on the 1915 standard rates, and therefore they have to surrender their share of surplus and their standard profits, and draw on reserves or obtain loans from their bankers.

Current Business.

There has been a slightly better inquiry on the market, more particularly for the superior grades of coal, both as regards large and small, and values continue to be very steady. In the case of some of the Monmouthshire qualities the position of collieries is not quite so satisfactory. Tonnage supplies are well maintained, and as chartering operations are fairly active, it looks very much as if the general tone of the market will be upheld to the end of the month. There has been no change in patent fuel or coke, while pitwood is not quite so steady. Anthracite coals are moving off pretty freely and prices are quietly firm.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	17/6 to 24/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 15 0	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 8 6	4 8 6
No. 1	4 9 0	4 9 0
Cleveland—		
No. 1	4 7 0	4 7 0
Silicious Iron	4 7 0	4 7 0
No. 3 G.M.B.	4 2 0	4 2 0
No. 4 Foundry	4 1 0	4 1 0
No. 4 Forge	4 0 0	4 0 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 5 0	—
(3) Northampton—		
Foundry No. 3	3 16 0 to 3 17 6	
„ Forge	3 10 0 to 3 12 0	
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 17 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	4 0 0	—
Basic	4 5 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 5 0 (a) / 5 10 0 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	—
Best „	—	—
N.E Coast—		
Common Bars	12 0 0	—
Lancs—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 5 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates, ½in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ½in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 15 0	—
Angles	9 10 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 0 0†	—
Light „	9 5 0 to 9 10 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	10 0 0 to 10 10 0	
„ (others)	9 15 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0 to 10 0 0	
„ (Lancs. Boiler)	13 0 0	—
Sheffield—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	
Intermediate Basic	9 0 0	
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 10 0	—
Soft Wire Rods	11 0 0 to 11 10 0	
Midlands—		
Small Rolled Bars	9 5 0 to 10 0 0	
Billets and Sheet-bars	7 10 0 to 7 15 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 10 0 to 17 12 6	
Angles	9 5 0	—
Joists	9 5 0	—
Tees	10 5 0	—
Bridge and Tank Plates	9 15 0	—
Boiler Plates	13 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/6 to 23/7½
Block Tin (cash)	260 10 0
„ (three months)	263 5 0
Copper (cash)	64 5 0
„ (three months)	65 7 6
Spanish Lead (cash)	40 0 0
„ (three months)	37 7 6
Spelter (cash)	35 18 9
„ (three months)	35 13 9
Manchester—	
Copper, Best Selected Ingots	70 0 0
„ Electrolytic	71 0 0
„ Strong Sheets	85 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 2½
Lead, English	42 15 0
„ Foreign	41 5 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro-Tungsten	1/4½d. per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
„ 6 p.c. to 8 p.c. „	£23 10 0	7/9
„ 8 p.c. to 10 p.c. „	£23 0 0	7/6
„ Specially Refined		
„ Max. 2 p.c. carbon	£43 0 0	16/-
„ „ 1 p.c. „	£52 0 0	17/6
„ „ 0.75 p.c. carbon	£60 0 0	20/-
„ „ carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
„ „ 75 p.c.	£17 17 6 scale 6/- per unit	
„ Vanadium	18/3 per lb.	
„ Molybdenum	7/9 per lb.	
„ Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£165	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	16/9
„ „ Ell	18/4½
„ „ Splint	20/- to 24/-
„ „ Trebles	19/9
„ „ Doubles	18/9
„ „ Singles	13/9
Ayrshire—	
(f.o.b. Ports)—Steam	16/9
„ „ Splint	20/-
„ „ Trebles	19/9
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	15/- to 17/3
Screened Navigation	24/6
Trebles	21/- to 22/6
Doubles	18/9
Singles	14/-
Lothians—	
(f.o.b. Leith)—Best Steam	17/3
Secondary Steam	16/3
Trebles	20/-
Doubles	18/9
Singles	13/6

ENGLAND.

(8) N.W. Coast—	
Steams	28/6
Household	45/- to 58/4
Coke	30/-
Northumberland—	
Best Steams	18/6
Second Steams	17/6 to 18/-
Steam Smalls	10/9 to 11/-
Unscreened	15/6 to 17/-
Household	23/6 to 25/-
Durham—	
Best Gas	21/-
Second	17/3 to 18/-
Household	23/6 to 25/-
Foundry Coke	23/-
Sheffield—	Inland.
Best Hand-packed Branch	32/- to 35/- —
Barnsley Best Silkstone	26/- to 28/- —
Derbyshire Best Brights	27/- to 32/- —
„ „ House	24/- to 26/- —
„ „ Large Nuts	22/6 to 25/- —
„ „ Small „	14/- to 16/- —
Yorkshire Hards	20/6 to 23/- —
Derbyshire „	20/6 to 23/6 —
Rough Slacks	9/6 to 12/- —
Nutty „	9/- to 11/- —
Smalls	5/- to 7/6 —
Blast-furnace Coke (Inland)*	— —
„ (Export)	f.o.b. 21/6 to 22/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	27/- to 27/6
Second „ „	25/6 to 26/6
Best Dry Large	27/- to 27/6
Ordinary Dry Large	24/- to 26/-
Best Black Vein Large	24/- to 24/6
Western Valley „	23/6 to 24/-
Best Eastern Valley Large	23/- to 24/-
Ordinary „ „	22/6 to 23/-
Best Steam Smalls	16/- to 18/-
Ordinary „	13/- to 15/-
Washed Nuts	22/- to 32/-
No. 3 Rhondda Large	27/- to 27/6
„ „ Smalls	19/- to 20/-
No. 2 „ Large	22/6 to 23/6
„ „ Through	18/- to 20/-
„ „ Smalls	11/- to 13/-
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	27/6 to 32/6
Patent Fuel	25/6 to 27/-
Pitwood (ex ship)	28/3 to 28/9
Swansea—	
Anthracite Coals	
Best Big Vein Large	47/6 to 50/-
Seconds	40/- to 45/-
Red Vein	34/- to 36/-
Machine-made Cobbles	59/- to 60/-
Nuts	55/- to 60/-
Beans	42/6 to 45/-
Peas	19/- to 23/-
Breaker Duff	9/6 to 10/-
Rubbly Culm	12/- to 12/6
Steam Coals:	
Large	22/6 to 23/6
Seconds	22/- to 22/6
Smalls	14/- to 16/-
Cargo Through	17/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated. coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast furnaces only, 16/9, with fluctuations according to analysis; open market, round about 22/6 to 25/- at ovens. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Trade Situation.

THE iron and steel trades are generally more active and orders would be given out more freely if makers could accept them, but the situation offers so many elements of uncertainty that there is every desire to restrict commitments ahead. The principal causes of hesitation are the negotiations now proceeding between the French and German representatives for a treaty of commerce and the new Tariff Bill, which is to be discussed shortly in the Chamber of Deputies. The negotiations are likely to drag along for a considerable time, and may be followed by further deliberations with a view of ensuring some stability to the iron and steel trades. The idea is fairly general that a recovery of the world's demand for material will be accompanied by a competition more severe than any previously experienced, and as evidence of this it is pointed out that the prices at which contracts are given out in South America are such as to leave no margin of profit. Whether or not the fear of serious price-cutting in foreign markets may be justified, it is nevertheless influencing the attitude of French makers, who are anxious to come to an understanding with the Germans for a control of the world's trade. The expressed fear is, it is probable, merely intended to justify an agreement which is equally necessary to the French and to the Germans. Unless the Germans should be too exacting, the next month or two may see the laying of the foundation for a reorganisation of the continental trade. The iron and steel industry here has developed so rapidly of late years that makers are anxious to take such measures as are necessary to ensure the predominant position on the Continent which they seem to be in a fair way of securing.

Engineering.

In the engineering departments the only contract of any importance is that secured by the Société Nationale des Travaux Publics de Paris for the construction of the port of Tangier at a cost of 21,898,951 francs. Before the Statute of Tangier was drawn up, the Sultan of Morocco, at the instigation of the French Government, gave the contract to a French company, but it had to be withdrawn at the instance of the other Governments interested as being irregular. Tenders were recently invited for the work and four estimates were submitted, and considerable satisfaction is expressed here at the contract being secured in France, although it is probable that certain foreign interests have not been overlooked. Generally, the engineering industries are only moderately active, and some, like the machine tool firms and wagon builders, are destitute of work. It is understood that the Government has made a concession to the wagon builders, who protested against Germany supplying rolling stock on account of reparation, by agreeing to authorise the railway companies to place some large orders, but the fear is expressed that the delays for delivery will be so short that the builders will be unable to execute the contracts, in which event the Government will be at liberty to procure the rolling stock from Germany.

Automatic Couplings.

A proposition has been presented in the Chamber of Deputies to render compulsory the use of automatic couplings on railway coaches. It is stated that during the past four years the number of accidents caused by the present system of coupling and uncoupling by hand was an average of 144 a year, of which 37 were fatal. The proposition provides that from January 1st, 1935 the railway companies will not be permitted to employ coaches and wagons that cannot be coupled automatically. As no international agreement has yet been come to for the equipment of wagons with uniform types of automatic couplings, the vehicles, until that date, are to be fitted with automatic couplings in combination with the existing system. Behind this proposition there is a strong agitation in Parliament in favour of the Boirault automatic coupling, which is the only French device that has given satisfaction. It has given good results in competitive tests and several hundreds of vehicles on the State lines have been equipped with it, while it has always been in use on the electric railway between the Invalides and Versailles. The preference being shown for the Boirault system is, however, arousing opposition in some quarters, where it is declared that other systems are at least equally as good, and that until these devices have been tested under the same conditions there is no reason for selecting any one type. Moreover, the selection should be left to the railway companies themselves.

U.S. Lines in Cherbourg.

It is reported that, on account of the difficulty of berthing the Leviathan in Southampton, the United States' Lines are in negotiation for transferring their port of call to Cherbourg. It is said that they propose to create a temporary berth at the extremity of the Homet jetty, which could be completed in about six months, and which would allow of the Leviathan being berthed pending the construction of a wharf in the Bay of Mielles. The American Government will defray the cost of all the work carried out specially for them. The American representatives are carrying out preliminary investigations with the Cherbourg Chamber of Commerce. A considerable amount of dredging work would be necessary.

Economies in Electricity.

A new method for ensuring that electrical plants shall always run at their maximum efficiency has been presented to the Academy of Sciences by M. Rateau on behalf of a Russian engineer, M. Michel Doloukhanoff. The system provides for the automatic cutting out of the machines according to the loads. In an installation, for example, comprising machines of respectively 100, 200, 400 and 800 kilowatts combinations are provided for giving automatically fifteen outputs of multiples of 100 kilowatts, the control being effected in accordance with the variations in demand.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

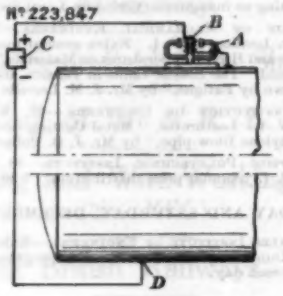
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

223,847. April 18th, 1923.—PREVENTION OF SCALE IN BOILERS. Dr. E. A. Heberlein, 61, Gracechurch-street, London, E.C. 2.

This inventor says that investigation and practical tests have shown that the protective effect of direct current, irrespective of the arrangement by which it is conducted to the metallic surfaces to be protected, is considerably strengthened if the protective current is alternatively interrupted or reduced and closed or increased. In Fig. 1 a permanent magnet A is fitted with a soft iron core to the top metallic surface of a boiler to be protected. The soft iron core is prolonged by a screw rod, adapted to screw into the bore of a countersunk screw—not

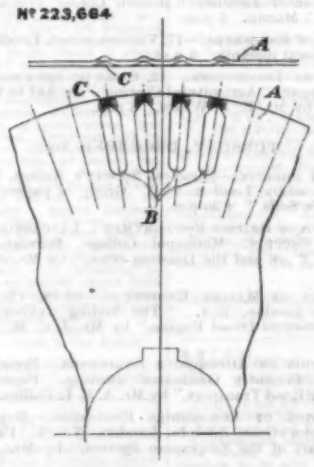


shown—which itself is screwed into the boiler. Round the core a steel spiral B is fixed, the lower end of which is wedged between the head of the screw and the core, while the other end is electrically connected to the positive pole of a thermo-pile or other source of small electromotive force C. The other pole of the thermo-pile is connected to the boiler at a point D on its surface below the water and remote from the other connection. As a result of the vibration of the boiler in action, the spring B constantly cuts the field of the magnet A, thus generating a current which alternately weakens and strengthens the protective current of the boiler continuously.—*October 30th*, 1924.

DYNAMOS AND MOTORS.

223,664. July 27th, 1923.—IMPROVEMENTS IN AND RELATING TO ELECTRIC MOTORS, The British Thomson-Houston Company, of Crown House, Aldwych, W.C. 2, and Robert Dumas, of 27, Lillington-road, Leamington Spa.

This invention relates more particularly to electric motors having cast aluminium rotors, and the object is to provide means for preventing the core plates buckling when the slots are made by the step-by-step notching process, and consists in making an indentation at the other end of each slot to absorb the additional length of material. In the usual method of making rotors of this type the plates taken from the centres of the stator punchings are notched, leaving a bridge of metal to retain the melted aluminium and then assembled on the rotor shaft. After casting-in the aluminium, the outside diameter is turned down to that required for the rotor. During the step-by-step notching process for punching the slots in the plate, the thin bridge of metal left at the outer end of each slot stretches, with the result that when a number of plates are assembled on the

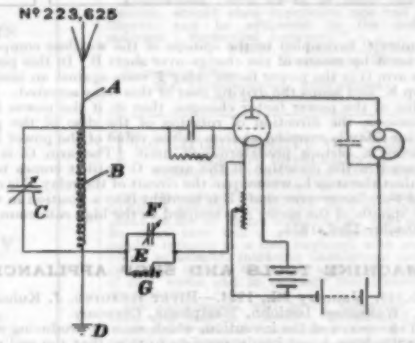


rotor shaft, they assume an extremely wavy form, owing to the buckle consequent upon the outside circumference of the punching being too long. One method of carrying the invention into effect is illustrated. A represents part of a rotor stamping provided with a number of slots B. At the outer end of each slot the stamping has an indentation C, the indentations giving a corrugated appearance to the circumference of the stamping. With this construction the extra length of material formed during notching is absorbed in the indentations, and buckling is practically eliminated. The core plates are usually assembled so that the slots are on a slight spiral, and the combined effect of the slot corrugation and the spiralling of the slots is to form a very slight space between successive core plates. This is of great advantage, as it allows the contraction of the aluminium when cooling to be uniformly spread over the whole length of the rotor core and reduces to a minimum the possibility of the fracture of the aluminium conductors. In cases where the slots are made by a compound die, in which event the amount of stretching of the bridge of metal on the outside of each slot would be negligible, the indentations would still be of use in effecting the uniform distribution over the length of the core of the amount of slackness necessary to allow for the contraction of the aluminium when cooling. The indentations may be produced either by a step-by-step process or by a multiple forming tool.—*October 27th*, 1924.

TELEGRAPHS AND TELEPHONES.

223,625. June 30th, 1923.—THERMIONIC VALVE CIRCUITS, Oliver Joseph Lodge, of Normanton House, Lake Salisbury, Wiltshire, and Edward Ernest Robinson, of Mount Lee, Egham Hill, Surrey.

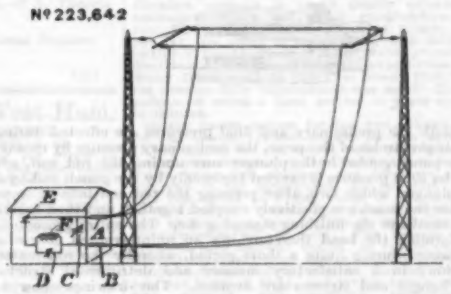
The invention relates in the use of a free uncoupled low-resistance oscillatory circuit capable of precise tuning and to be stimulated by oscillations from any place where oscillating currents are passing or where there is an oscillating potential, to work up oscillations of one definite frequency into considerable amplitude by sympathetic resonance, and to transmit those enhanced oscillations of potential and no others to another circuit or device in which they are utilised, such as a thermionic valve or a crystal detector. An important application of the invention is to receiving apparatus for radio telegraphy or telephony, where its use secures accurate selection combined with clear and strong articulation without reaction and with exclusion of extraneous disturbances. The transmission of the



enhanced oscillations may be effected by direct connection or by coupling, provided the oscillator is only coupled to a detector which takes so small a current as not to interfere with its free oscillation. It is a transmitter of alternating potential rather than of alternating current. The antenna A, inductance B, condenser C, and earth connection D belong to any usual antenna circuit. In the example illustrated, connection is made from the antenna circuit to the grid of the valve in a usual way through a leaky condenser. In the connection between the antenna circuit and the filament, there is interposed an oscillatory circuit E, comprising a condenser F and inductance G, one or both of which may be variable. It will be understood that if the valve is used for high frequency amplification, the leaky condenser may be omitted, or any other usual modification may be introduced into the circuit. The invention lies in the provision of the oscillator E, which can also be inserted in the grid circuit.—*October 20th*, 1924.

223,642. July 23rd, 1923.—IMPROVEMENTS IN AND RELATING TO APPARATUS FOR THE SELECTIVE RECEPTION OF RADIO TELEGRAPH AND RADIO TELEPHONE SIGNALS, Alexander William Sharman, of 1, Morella-road, Wandsworth Common, S.W.

The inventor's object is to provide an aerial system and associated apparatus which will receive signals of greater intensity and which will give greater selectivity than is possible with aerial systems at present in use. The scheme is also claimed to reduce interference as the result of atmospheric disturbances. It will be seen that there are two lead-in wires. Across the terminals A and B a variable condenser C is connected. A loop aerial of considerable dimensions is thus provided. Across the condenser C suitable receiving apparatus of an usual or any desired type may be connected, a detector being shown at E. Owing to the low decrement and small re-radiation from a closed circuit



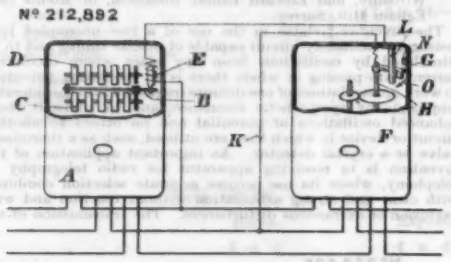
of this kind, aerials of this type are in themselves highly selective, but, according to this invention, the leads to the detector element from the tuning condenser are taken through suitable closed oscillatory circuits comprising inductances F and variable condensers D, connected in shunt, so as to form resonant rejector circuits, which are tuned to the wave length of the station it is desired to cut out. Only one of such rejector circuits is illustrated, but any desired number may be employed. In using aerials in accordance with this invention, it has been found possible to obtain considerably greater signal strength than that procurable when using an open circuit aerial of the same superficial area. Further, it has been found that atmospheric disturbances are greatly reduced, and that the directional qualities common to the usual small frame aerial of well-known type are rendered less conspicuous by the introduction of what is termed the "vertical effect."—*October 23rd*, 1924.

MEASURING AND TESTING INSTRUMENTS.

212,892. March 14th, 1923.—DEVICE FOR MEASURING THE WATTLESS LOAD OR WATTLESS ENERGY IN SINGLE OR POLYPHASE ALTERNATING CURRENT CIRCUITS, Landis and Gyr S.A., of Zug, Canton Zug, Switzerland.

According to this invention, a power factor relay is employed to alternate the change-over device of a two-rate meter, by means of which two integrating mechanisms are alternately connected to and disconnected from the meter spindle. In the drawings, A denotes a meter measuring the wattless energy and having two integrating mechanisms, and a change-over shaft B, the

rotation of which is transferred to one or other of the counters C D, according to the position of the shaft B. The change-over gear B is controlled by an electro-magnet E. F denotes the power factor relay in which an arm G is rigidly mounted on a slow-running spindle H, driven through reduction gearing by the relay spindle. The arm G is connected by a wire K to one of the mains of an alternating-current supply, to which are connected the wattless component meter A and the power factor relay F. A current conducting stop L, mounted on and insulated from the case, projects into the path of the arm G, and is connected to one end of the relay coil E, the other end of this coil being connected to the alternating-current supply. Normally, the low-rate

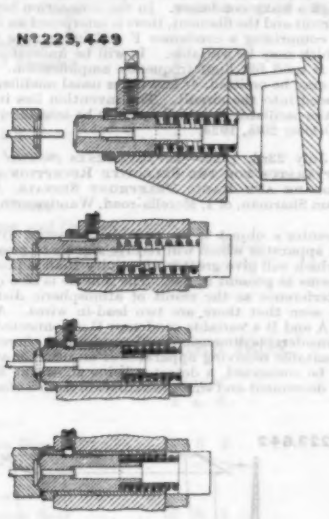


counter C is coupled to the spindle of the wattless component meter A by means of the change-over shaft B. In this position the arm G in the power factor relay F rests against an insulated stop N, and keeps the driving gear of this relay arrested. If the value of the power factor changes, that is, if the power factor decreases, the direction of rotation of the disc of the power factor relay is reversed as soon as the value of the power factor reaches a certain predetermined limit. The arm G is then rotated in the direction of the arrow O until it comes to rest against the stop L, whereupon the circuit of the relay E is closed and the change-over shaft B is brought into a position in which the spindle of the meter A is coupled to the high rate counter C. —*October* 23*rd*, 1924.

MACHINE TOOLS AND SHOP APPLIANCES.

223,449. January 9th, 1924.—Rivet Heading, J. Kuhne, 14, Wolfsgasse Iserlohn, Westphalia, Germany.

The essence of the invention, which aims at producing exceptionally large upset heads, consists in this, that the end of the stock or rod is worked up into the form of a head by the application of a single, continuous pressure effected in the following way. The rod end is first of all surrounded by a sleeve or hollow plunger and then, by the application of pressure only on the cross section of the rod, is pressed out of the sleeve or plunger, and into the head-forming mould or matrix, wherein the mass of the rod end becomes spread out or upset. Immediately on this, but during the same pressure movement, the head is pressed into its final shape by pressure exerted on the entire face of the head.

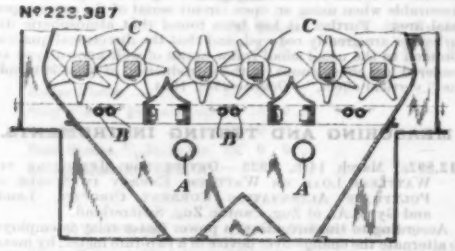


Both the preliminary and final pressures are effected during a single stroke of the press, the preliminary pressure by means of a punch guided in the plunger surrounding the rod end, while the final pressure is exerted commonly by the punch and by the plunger, which two, after pressing the rod end into the mould for the head, are positively coupled together, and then together constitute the finishing stamping die. The entire procedure of forming the head therefore has an uninterrupted course and occurs during quite a short period, whereby the rod material flows in a satisfactory manner and detrimental structural changes and stresses are avoided. The drawings show four successive stages in the process of making a head.—*October* 23*rd*, 1924.

MISCELLANEOUS.

223,387. October 3rd, 1923.—Low-temperature Distillation, Merz and McLellan, Collingwood, Buildings, Newcastle-on-Tyne, and E. G. Weeks, 11, Park-terrace, Dunston, Durham.

The inventors say that they have found in connection with



low-temperature distillation that a more efficient distillation is possible with the use of less steam and at a lower temperature if a certain amount of additional heat be generated within the retort itself by the addition to the heated steam of a regulated amount of air so as to cause the combustion of a limited proportion of the fuel within the retort. The present invention comprises, therefore, a low-temperature fuel-distillation process in which steam is passed through the fuel in a retort, characterised by supplying such a quantity of air to the fuel in addition to the steam, and pre-heating the steam and/or the air, so that the mixture of air and steam is raised to a temperature about at or above the ignition temperature of the fuel, whereby ignition takes place of a small quantity only of the fuel in the retort. The steam is admitted at the bottom of the retort by the pipes A A, while the air is supplied by the pipes B B. C C are the coke-extracting rollers.—*October* 23*rd*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institute of Transport.—Council Chamber, Town Hall, Leeds. Meeting to inaugurate Yorkshire Local Section. 6 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Extra general meeting. "The Effect of Low and High Temperatures on Materials," by Professor F. C. Lea; and "The Elastic Limit in Tension, its Influence on the Breakdown by Fatigue," by Mr. J. M. Lessells. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Metal Cutting under Water by the Oxy-acetylene Blow-pipe," by Mr. J. B. Pollard. 7.30 p.m.

Northampton Polytechnic Institute.—St. John-street, London, E.C. 1. Annual prize distribution. 7.30 p.m.

TO-DAY AND SATURDAY, DECEMBER 6th.

South Wales Institute of Engineers.—Exhibition at the Drill Hall, Dumfries-place, Cardiff. For programme see page 591. 2 p.m. each day.

SATURDAY, DECEMBER 6th.

Institute of British Foundrymen: Birmingham Branch.—Chamber of Commerce, New-street, Birmingham. "Malleable Iron," by Mr. D. Wilkinson. 4 p.m.

Institute of British Foundrymen: Lancashire Branch.—College of Technology, Sackville-street, Manchester. Paper "Spun Iron Pipes," by Mr. R. A. Miles. 4 p.m.

Institution of Municipal and County Engineers.—City Engineer's Office, City Hall, Cardiff. South Wales District meeting. 3 p.m.

Institution of Municipal and County Engineers.—Council Chamber, Bradford. Yorkshire District meeting. 2.30 p.m.

Northampton Polytechnic Institute.—St. John-street, London, E.C. 1. Members' and students' annual conversazione. 6.30 p.m.

MONDAY, DECEMBER 8th.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper, "Ships' Propellers," by Mr. S. E. Flack. 7.30 p.m.

Institution of Automobile Engineers.—The College, Loughborough. Loughborough Graduates' Meeting. Paper, "Modern Developments in Car Design," by Mr. W. P. Johnson. 7 p.m.

Institution of Automobile Engineers: Birmingham Centre.—Chamber of Commerce, New-street, Birmingham. Paper, "Some Experiments on Gas Explosion in Closed Tubes, with Particular Reference to 'Pinking,'" by Mr. J. D. Morgan. 7 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "Modern Colour Problems, III.," by Dr. L. C. Martin. 8 p.m.

Society of Engineers.—17, Victoria-street, London, S.W. 1. Annual general meeting. 6 p.m.

Surveyors' Institution.—12, Great George-street, London, S.W. 1. Paper, "Agricultural Costing: An Aid to Farm Management," by Mr. E. P. Weller. 8 p.m.

TUESDAY, DECEMBER 9th.

Faraday Society.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Group of papers on "Base Exchange in Soils." 4.30 p.m.

Institute of British Foundrymen: Lancashire Branch, Burnley Section.—Municipal College, Burnley. Paper, "Foundry Work and the Drawing-office," by Mr. A. Sutcliffe. 7.15 p.m.

Institute of Marine Engineers.—85-88, The Minories, Tower-hill, London, E. 1. "The Sliding Cylinder, Double-acting, Two-cycle Diesel Engine," by Mr. J. C. M. MacLagan. 6.30 p.m.

Institution of Automobile Engineers.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Steam Vehicles for Road Transport," by Mr. A. E. L. Collins. 7.15 p.m.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Tyre as Part of the Suspension System," by Mr. A. Healey. 7 p.m.

Institution of Electrical Engineers: Scottish Centre.—Room 149, Royal Technical College, George-street, Glasgow. Paper, "An Electric Harmonic Analyser," by Messrs. J. D. Cockcroft, R. T. Coe, J. A. Tyacke, and Professor Miles Walker. 7 p.m.

WEDNESDAY, DECEMBER 10th.

Institution of Automobile Engineers: North of England Centre.—Milton Hall, 244, Deansgate, Manchester. Informal meeting. 6.30 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Informal meeting. Discussion on "Suitable Fendering for Tidal Berths," introduced by Mr. Ernest Latham. 7 p.m.

Institution of Engineers-in-Charge.—St. Bride Institute, Bride-lane, Fleet-street, E.C. 4. Presidential address, "Responsibilities and Training of the Engineer-in-Charge," by Mr. T. Cooper. 7.30 p.m.

THURSDAY, DECEMBER 11th.

Institute of Metals: London Local Section.—Institute of Marine Engineers, 85-88, The Minories, London E. 1. Joint meeting with the Institution of British Foundrymen. Paper, "Present Problems and Developments in Engineering Bronze Foundry Practice," by Mr. F. W. Rowe. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, London, S.W. 1. Joint meeting with The Institution of Mechanical Engineers, The Institution of Electrical Engineers, The Institution of Naval Architects, The Institute of Marine Engineers, The North-East Coast Institution of Engineers and Shipbuilders, The Institution of Engineers and Shipbuilders in Scotland, The Institute of Chemistry of Great Britain and Ireland, The Institution of Gas Engineers, The British Electrical and Allied Manufacturers' Association, The British Engineers' Association. Discussion on "Standards of Comparison in Connection with the Thermal Efficiency of Steam Engines," introduced by Captain H. Riall Sankey. 6 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. Address, "Radio Communications," by Senatore G. Marconi. 8 p.m.

FRIDAY, DECEMBER 12th.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. Discussion on "The Design of Furnaces for Annealing and Heat Treatment," to be opened by Mr. T. Hill. 7.15 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Paper, "Fluid Transmission Gears," by Mr. H. G. Bonly. 7.30 p.m.

SATURDAY, DECEMBER 13th.

Institute of British Foundrymen: Lancashire Branch, Junior Section.—College of Technology, Manchester. Paper, "The Value of Technical Information in Foundry Work," by Mr. F. W. Rowe. 7 p.m.

Institution of Civil Engineers.—Students' visit to the Research Laboratories of the General Electric Company, Limited, Wembley.

MONDAY, DECEMBER 15th.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Extra informal meeting to discuss the new Wiring Regulations of the Institution. 7 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section meeting, "Some Aspects of Works Management, with a View to Cutting Costs of Production,' by Mr. E. G. Davies. 7 p.m.

Junior Institution of Engineers: North-Western Section.—Demonstration Hall of Pathé Frères, 15, Deansgate, Manchester. Lecture, illustrated by film, "Fire Fighting, Ancient and Modern," by Mr. G. E. Taylor. 7.15 p.m.

TUESDAY, DECEMBER 16th.

Institution of Engineers and Shipbuilders in Scotland.—Rankine Hall, Elmbank-crescent, Glasgow. Paper, "The Internal Combustion Locomotive," by Mr. James Dunlop. 7.30 p.m.

Institute of Marine Engineers.—85-88, The Minories, Tower-hill, London, E. 1. "Development of Steam and of Oil Engine Machinery for Propulsion," by Mr. E. G. Warne. 6.30 p.m.

WEDNESDAY, DECEMBER 17th.

Institution of Mechanical Engineers.—Graduates' visit to Fry's Metal Foundry, Blackfriars, S.E.

Newcomen Society.—Prince Henry's Room, 17, Fleet-street, London, E.C. 4. Paper, "The Development of the Cylinder Boring Machine," by Mr. E. A. Forward. 5.30 p.m.

Radio Society of Great Britain.—Institution of Electrical Engineers, Savoy-place, London, W.C. 2. Annual general meeting. Lecture, "Photo-electrics," by Mr. C. F. Elwell. 6 p.m.

THURSDAY, DECEMBER 18th.

Institution of Mechanical Engineers.—Connaught Rooms, Great Queen-street, London, W.C. 2. Institution dinner. 6.45 for 7.15 p.m.

FRIDAY, DECEMBER 19th.

Institution of Automobile Engineers.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. Paper, "Tooth Gearing," by Mr. H. E. Merritt. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Second Report of the Wire Ropes Research Committee. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, Westminster, London, S.W. 1. Lecture, "Aircraft in Japan, Preceded by a Few Experiences of the King's Cup Race, 1924," by Colonel the Master of Sempill. 7.30 p.m.

SATURDAY, DECEMBER 20th.

Institution of Automobile Engineers.—London Graduates' visit to the works of J. A. Prestwich and Co., Limited, Northumberland Park, Tottenham. 2.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Fuller's United Electric Works, Limited, of Chadwell Heath, Essex, has taken new premises in connection with its Bristol depôt at 22, Temple-street (telephone, Bristol 2531).

We are informed that Mr. Charles Findlay, formerly Glasgow representative of the Independent Pneumatic Tool Company, of 40, Broadway, Westminster, London, S.W. 1, has been appointed district manager of that company.

Alfred Herbert, Limited, of Coventry, asks us to state that, whereas for many years it has acted in conjunction with another company as joint selling agents in Great Britain and Ireland for Norton grinding wheels, arrangements have now been made by which it will in future act as sole selling agent for all Norton wheels in the territory mentioned.

Dr. H. C. Watts informs us that following the voluntary liquidation of Ogilvie and Partners, Limited, he is continuing his side of that business as a consultant in aerodynamic matters at 3, Grosvenor-gardens, London, S.W. 1 (telephone, Streatham 4036; telegrams, Walsheff Sowest London). He has given up his former address at 104, High Holborn, W.C. 1.